SCIENCE.

FRIDAY, SEPTEMBER 11, 1885.

THE AMERICAN ASSOCIATION AT ANN ARBOR.

It is well known in what a dilemma the association was placed at the close of the Philadelphia meeting. Without an authorized invitation from any community to hold this year's meeting within its bounds, and propelled by the desire to find cooler quarters than those occupied in Philadelphia, the council hesitated between Mount Desert and Ann Arbor. It is hard for a college professor to cut short his summer rest, and hurry back to make his *confrères* happy during their week's stay near his lecture-room; and it is especially to be regretted, that each year some well-worked men give up their whole vacation, or add to their working hours, that the expected visitors may be kindly cared for. If there is any reward for this unselfish labor, it comes in the satisfaction with their reception shown by the invaders. And we are confident that all who have been present at the Ann-Arbor meeting will be glad that the proprietors of the hotels of Mount Desert turned a deaf ear to the proposals of the association secretary; and that the citizens of Ann Arbor, urged perhaps a little by Prof. J. W. Langley, tendered to the association the use of their halls and houses, and the promise of a kindly welcome.

On every side were heard expressions of pleasure at the arrangements of the local committee. The rooms of the university furnished the most convenient meeting-places the association has used for many years. The meeting was not a large one, the total attendance of members reaching only 364; but the quality, if not the number (176), of papers presented was up to the average.

During the meeting, two changes were made in the organization. By one, the section of histology and microscopy was abolished. This change has been urged for some time by those who do not think a special science of microscopy exists, but that the microscope is a tool used by scientific men in various branches. The other change was in the name of the section of mechanics, the words 'and engineering' being added to the title, that it may be more clearly understood by Americans that those interested in all branches of engineering are invited to take part in the proceedings.

As this was the first meeting of scientific men since the action of the government in regard to the coast-survey, it is not surprising that the question should have been discussed in private and by the council. The matter was referred to a committee, which offered a series of resolutions given on another page. At the Friday meeting, when the report of this committee was made to the society, the interest of those present was shown by the eager gathering into a more compact body, that the debate might be the more readily followed. The discussion proved to be purely formal, no one offering any objection to the resolutions, which were unanimously accepted as the sense of the meeting. Indorsing remarks were made by Prof. S. P. Langley, Dr. James Hall, Prof. T. C. Mendenhall, and others.

In every direction, one sees at the association meetings the conspicuous badge of the reporter; and each secretary, at the close of the session of his section, is approached by discomfited members of the press, for at least a few suggestions as to what the talk has all meant. Each day, one is urged by the newsboy to buy a 'full account' of the proceedings. He may find some information as to the programme, but will probably be disappointed in the report of the papers and discussions, even of those which could be made interesting to the laymen. There are always a few eccentric individuals present, and these furnish a fruitful theme for the reporters' wit; and the officers of the association come in for a share of attention.

But an account of the meeting which should convey to the public any idea of what it is all about is wanting.

We have again to call attention to the unsatisfactory nature of the reports of the special committees of the association. While in England much of the most valuable work of the corresponding association is the result of investigations carried on under the guidance of its committees, in our association the reports consist mostly of a mere statement that the majority of the members are alive and well, and would be glad to be continued as a committee of the association for another year. As a conspicuous exception, we would call attention to the report on stellar magnitudes, due to the exertions of Prof. E. C. Pickering, which is to be printed in full. The botanists also have brought about some good results.

Some of the statistics of the meeting may be of interest. The number of papers presented was naturally not so large as last year, but exceeded that at any recent meetings in the west; the largest number being presented in section F (32), followed at no great distance by sections B (23), E (27), and H (26). Section G, with its four papers, held but one day's session, and was then merged in F. Section D, with twelve papers, completed its work in two of the four days given to papers. Section A, however, with the same number, remained in session three days; and though the sessions of B closed also on the third day, C and I, with fewer papers (17 and 21 respectively), continued through the four days. One hundred and fifty-four new members were elected, sixty-eight members were advanced to fellowship, and three hundred and sixty-four members and fellows were in attendance.

Although the meeting was a small one, the necessity of despatching business with greater promptitude was so apparent, that additional changes in the constitution were proposed to effect this, besides those which could be decided at this meeting. In accordance with a formal proposition last year, it was decided to elect members by the standing committee instead of in general session; but the association thought it would also be wise to select the fellows in the same way, and the need of a daily general session preceding the sectional meetings was thus less obvious. The general session is undoubtedly advantageous as bringing together once a day all the members of the association, but very disadvantageous to its work; since after a half hour so spent, the members divide into the various sections, often at some distance from each other, and much delay and confusion result. It is proposed to restrict the general sessions to the beginning and close of the meeting, and to limit the public reading of committee reports in general session to such as seem to the standing committee specially desirable from their interest or importance. All these are excellent propositions, and will come up for decision next year.

The next meeting will be held at Buffalo, N.Y., beginning Aug. 18, 1886, under the presidency of Prof. Edward S. Morse of Salem, Mass.

THE COMMITTEE REPORTS.

THE following is a general account of the reports of committees made to the association at its general session, Monday morning, Aug. 31:—

The committee on the best methods of science-teaching in the public schools reported, through Hon. John Eaton of Washington, that considerable progress had been made, and that everywhere various associations and schools, as well as individuals, were working upon the subject, and many important experiments had been made. The committee, however, was not prepared to make more than a verbal statement, and, on its request, was continued.

The committee on the registration of deaths, births, and marriages, reported, through Mr. E. B. Elliott of Washington, that the object of this committee was to bring about the co-operation of the government of the United States and the several states in establishing a uniform and efficient system of registration. Bills have from time to time been presented by committees of congress, — the last congress having, in both houses, considered bills identical in character, — but, for various reasons, delay had prevented action. There had been no adverse action: the bills had received the hearty co-operation of many earnest friends in both houses, and favorable action in the near future might be expected. The information desired to be secured would be useful to individuals in securing the legitimate descent of heritable property,

which necessarily changes ownership on an average three times a century; useful to people at large in determining the relative salubrity of localities when compared with the census returns; and especially useful in preparing tables of annuities, and other tables bearing on the duration of human life. On the request of the committee, it was continued.

The committee on stellar magnitudes reported that the chairman of the committee, Prof. E. C. Pickering, was to have sent an elaborate report with tables, which had been considered in committee; but probably, by some miscarriage, it had failed to reach the general secretary. On recommendation of the standing committee, it was voted that the report should be printed, and the committee continued.

The committee to confer with committees of foreign associations for the advancement of science, with reference to an international convention of science associations, reported, through Dr. C. S. Minot, as follows: —

This committee reports that it has conducted an extensive correspondence, and made considerable progress. The question of an international convention in London is now before the British association, and dependent upon its action, which cannot be reached before its meeting in Aberdeen. The committee is not at liberty to publish the correspondence; but it feels that much progress has been made, and it seems not improbable that a meeting will be held in London within a few years. Owing to the liberality of Mrs. Elizabeth Thompson of Stamford, Conn., an endowment has been secured, and twenty-five thousand dollars placed in the hands of a board of trustees, the income to be expended in the promotion of pure science by the international convention when organized. For this, Mrs. Thompson deserves the thanks of our association. A fuller account of this will be found in *Science* for Aug. 28. In regard to the gift of Mrs. Thompson, this sum of twenty-five thousand dollars comes in five thousand dollars presented last year by Mrs. Thompson, and twenty thousand dollars presented by her this last spring. The two sums have been placed together: a board of trustees has been organized, with Dr. H. B. Bowditch of Boston as Chairman; and having for its other members, Mr. William Minot as treasurer, President F. A. Walker of the Massachusetts institute of technology, Prof. E. C. Pickering of the Harvard observatory, and Dr. C. S. Minot as secretary. Mrs. Thompson, seeing the international association might not immediately come into existence, and desiring to render her fund immediately available for the promotion of science, has very liberally empowered the trustees to expend the income in such manner as shall seem to them desirable, until it shall be transferred to the board for which it is ultimately designed. In consequence of this liberality of Mrs. Thompson, we shall have at our disposal a considerable sum, available this autumn, which will be appropriated in some manner for pure investigation or research of some kind yet to be determined; and the board of trustees will make a public announcement of the manner in which appropriations may be made from this endowment. I myself, continued Dr. Minot, regard this endowment, from the very liberal terms in which it was made, as one of exceptional value; and it seems to me that this association should, in the most cordial manner in its power, express to Mrs. Thompson its thanks for her liberality to science. I have further to report, on behalf of the standing committee, its recommendation that the report of this committee be accepted, and the committee continued, and the name of the committee changed from its present very long title to the 'Committee on international scientific congress.' The recommendation of the standing committee was adopted, and the standing committee was directed to prepare a suitable resolution of thanks to Mrs. Thompson.

The committee on the International congress of geologists reported that two members of the committee would attend the coming congress in Berlin, and a report should be expected at the next meeting of the association.

The committee in relation to duties on scientific books reported progress, and requested that the names of Professors Baird, Newcomb, and Mendenhall should be added to the committee, and this was done.

The committee on the uniformity of graphic illustrations in representing facts of statistics, etc., reported that the committee had been formed at the instance of Mr. Francis B. Hough, since deceased. The remaining members of the committee recommended its discontinuance, as no one of them was ready to undertake the charge of the work which Dr. Hough had planned: the committee was discharged.

The committee appointed at the last meeting of the association upon the encouragement of researches upon the health and diseases of plants, reported through Mr. J. C. Arthur, that, considering that its most important work was to secure the coöperation of the department of agriculture at Washington, it had urged upon the commissioner the establishment of a bureau or division in that department for the study of plant-diseases, especially those affecting fungi; and urged upon him, that, in the appointment of an officer to make such investigations, he should select a man whose training had been such as to enable him to call to his aid all the knowledge and appliances of the best modern scientific methods. In accordance with the recommendations of the committee, the commissioner reported his hearty sympathy with the objects of the committee, and announced that he had appointed Mr. F. L. Scribner of Girard college, Philadelphia, to take charge of such work for the department. On the recommendation of the standing committee, this committee was reconstituted with the following members: J. C. Arthur, C. E. Bessey, T. J. Burrill, W. G. Farlow, and Charles V. Riley.

Other committees reported progress, and were continued. Some of their reports were, by recommendation of the standing committee, read in the section to which the subject appertained. One or two committees were discharged.

THE RESOLUTIONS CONCERNING THE COAST-SURVEY.

The following are the resolutions referred to in our leading article, and unanimously passed by the association at its general session of Aug. 28: —

Whereas, The attention of this association has been called to articles in the public press, purporting to give — and presumably by authority — an official report of a commission appointed by the Treasury department to investigate the condition of the U. S. coast-survey office, in which report the value of a certain scientific work is designated as 'meagre;'

And whereas, This association desires to express a hope that the decision, as to the utility of such scientific work, may be referred to scientific men, —

Resolved, That the American association for the advancement of science is in earnest sympathy with the government in its every intent to secure the greatest possible efficiency of the public service.

Resolved, That the value of the scientific work performed in the various departments of the government can be best judged by scientific men.

Resolved, That this association desires to express its earnest approval of the extent and high character of the work performed by the U. S. coast-survey, — especially as illustrated by the gravity determinations now in progress, — and to express the hope that such valuable work may not be interrupted.

Resolved, That this association expresses, also, the hope that the government will not allow any technical rule to be established that shall necessarily confine its scientific work to its own employees.

Resolved, That in the opinion of the American association for the advancement of science, the head of the coast-survey should be appointed by the president, by and with the advice and consent of the senate, should have the highest possible standing among scientific men, and should command their entire confidence.

Resolved, That copies of these resolutions shall be prepared by the general secretary, and certified by the president of the association and by the permanent secretary, and shall be forwarded to the president of the United States, and the secretary of the treasury, and given to the press.

PROCEEDINGS OF THE SECTION OF ASTRONOMY AND MATHEMATICS.

Perhaps the small number of members in attendance, especially in section A, and the consequent dearth of papers, may have been, in the minds of the sectional committee, a sufficient excuse for the appearance of the first two numbers upon the programme; but it would certainly be far better to reduce the number of meetings of the section in such a case, and thus grant its members more opportunity for hearing valuable papers in others, than to occupy its time, and detract from its dignity, by the serious consideration of such material as that first offered to the section of mathematics and astronomy. The first of these choice contributions was by Mr. Thomas Bassnett of Jacksonville, Fla., entitled 'Intimate connection between gravitation and the solar parallax.' The only important truth stated in the paper, the one set forth as a new and important discovery, and the principal feature of the matter, was simply another way of stating Kepler's third law, and offers no method whatever of determining the solar parallax. The rest of the paper was principally nonsense. The next paper by Mr. S. S. Haight upon 'Rapidity of calculation,' etc., was only a *résumé* of some short cuts, principally in cross-multiplication, which are given in many elementary arithmetics, and are familiar, or would suggest themselves, to any one having occasion to make any extended computations in that manner; while the speaker's remarks about the use of logarithms only served to show his ignorance of the whole matter.

The section then settled down to the consideration of serious business in listening to a paper by Prof. H. A. Newton of Yale college, upon 'The effect of small bodies passing near a planet upon the planet's velocity.' The former researches of Professor Newton, upon meteors, are recognized among astronomers as our principal source of knowledge about the character, distribution, and motion of these minute bodies with which the solar system is filled, especially those which strike our atmosphere, and are burned up as meteors. The possible effect of these upon the rotation of the earth, and the revolution of the earth and moon in their orbits, has been subjected to elaborate investigation at the hands of several mathematical astronomers. The recent publications of Mr. Denning of Bristol, Eng., claiming the fixity of long-continuing radiant points of meteor streams, have raised the question of the existence of broad streams of meteoroids moving swiftly through stellar space outside of solar attraction; and any new investigation bearing upon any of these points is more than usually timely. In this paper Professor Newton has discussed the effect upon the earth's motion of those bodies which do not pass near enough to the earth to be drawn into its atmosphere, but still near enough to be drawn out of their course, and swung for a time in hyperbolic orbits round it. He began by saying that the results of the investigation might perhaps be considered negative as far as measurable quantities in the solar system are concerned, but that they had a mathematical interest, and might possibly have a bearing upon somewhat similar questions in molecular physics, like the kinetic theory of gases. The mathematician and astronomer must be referred to the paper itself, but the results of popular interest may be briefly summarized as follows: Considering, first, the case of a cylindrical stream of small bodies evenly distributed, and all moving in the same direction with a common velocity past the earth supposed to be in the axis of the cylinder, it is shown that they will communicate to the earth in each unit of time a velocity along the axis: 1°, that is proportional to the density of the group; 2°, that decreases as the

velocity increases, nearly inversely as the square of the velocity; 3°, that increases as the logarithm of the radius of the cylinder, the radius being measured by a unit differing from the earth's radius by a small quantity, which is a function of the velocity. Second, in the case of a widely extended group of small bodies evenly distributed in space, and having speeds all equal, but directed towards points evenly distributed over the celestial sphere with the earth moving in a right line through them, it is shown that, for those which do not strike the earth, but only affect it by their attraction, the effect will be an exceedingly minute acceleration of the earth's motion, if the latter *is less than that of the bodies*, even though the group is infinite in extent. If the earth's velocity *is greater than that of the bodies*, their total effect will consist of two parts; a very minute retardation of the earth's motion depending in amount upon the absolute velocity of the bodies, and another retardation depending upon the assumed extent of the group. In conclusion, the effect of bodies *striking* the earth or moon is manifold greater than that of those only *passing near*; and since it has before been shown that any admissible magnitude of meteoroids would make the effect upon the moon's mean motion of those which strike it only a minute fraction of the observed acceleration, still less can any action of those passing near the moon have any appreciable effect. The hour of adjournment prevented any discussion of this interesting paper.

The first paper of Friday's session was by Prof. Wm. Harkness of the U. S. naval observatory upon the flexure of transit instruments. The time-observations of the different transit-of-Venus parties in 1874 and 1882, — and the latitude observations as well, — were made with transit instruments of the 'bent' or 'broken' pattern; i.e., a totally reflecting prism is placed in the tube of the axis, and thus one-half of the axis itself forms a part of the telescope tube, the eye-piece and micrometer being at one end of the axis. This form, while allowing great convenience and rapidity of manipulation, introduces new difficulties through the flexure in the support of the central prism; and the discussion of these has led Professor Harkness to make a thorough investigation of the flexure of transit instruments from the most general standpoint. The details are of too technical a character for popular presentation; and we can only state the general nature of the subject, and give a brief summary of the points brought out. Astronomers, in the most exact measurements possible with their instruments, have always been obliged to consider even the most rigid of them as elastic, and as bending differently under the force of gravity as they are swung into different positions. But if they are entirely symmetrical in construction with reference to a vertical plane, it is generally assumed that the entire flexure takes place parallel to that plane; and hence that the line of collimation determined by reversal upon a collimator, or by a pair of opposite collimators, is at right angles to the axis when corrected for inequality and irregularity of pivots. But the special point of Professor Harkness's paper was, that, on account of unequal elasticity in the different parts of any instrument, this condition could only be certainly fulfilled when the direction of gravity through the instrument was not changed by the operation. This could only be done by reversal either upon a *zenith-collimator* or *over the nadir*, and in these two positions only could the line of collimation be considered as rigorously at right angles to the axis. The other conclusions were, that for the particular zenith distance at which a line of collimation is determined, that line possesses the essential properties of a line at right-angles to the axis, but for no other zenith distance; and that flexure at right angles to the meridian consists of two parts, the larger of which is measurable by a pair of collimators, but the smaller is only determinable by star-transits. For field instruments this method would be feasible; but in the case of larger meridian instruments, which are supposed to correct the positions of the stars, this would hardly be allowable in fundamental work. Prof. H. M. Paul of the naval observatory remarked that the results of the paper emphasized anew the necessity, in the great bulk of meridian observations, of work in zones, the positions of the zero-stars in these zones depending upon some good fundamental system like that of Auwers; and also, in the formation of such a system of fundamental positions, the advantage of giving greater weight to the work of different observatories upon the stars which culminated near their zeniths, provided they could determine their collimation by reversal upon a zenith collimator.

The next paper was by Prof. G. W. Hough, director of the Dearborn observatory at Chicago, describing some improvements recently introduced in the printing-chronograph, first designed and brought into use by himself at the Dudley observatory in 1871. This instrument is designed to print upon a fillet of paper the minutes, seconds, and hundredths of seconds, indicated by the clock which controls it, at any instant when an observing-key is closed by the observer's finger. The impression is made from the surface of three continuously running type-wheels, the swiftest of which revolves once per second, and is controlled each second by the standard clock. The recent improvements consist in engraved type on the face of the wheels in place of the rubber ones used at first, which required too frequent renewal; and of the substitution of a direct blow by an electro-magnet upon the type-wheel fillet, thus making the apparatus much more light and compact than the old form. For this Professor Hough uses three cells of a storage battery, each of about two volts electromotive force, and from 0.3 to 0.4 of an ohm resistance, thus furnishing a strong current for the printing-magnet. The cells are kept permanently coupled to the chronograph, and are charged by eight small gravity cells having a resistance of 7 to 10 ohms each. He claimed that it was perfectly reliable, and eminently a labor-saving machine; and described its use in making transit observations as a luxury that no one would do without after trying it, the mean of the seconds and hundredths being taken directly

on the fillet without transferrence to books. In response to inquiry, he stated that the difficulty in getting a circuit through a clock-pendulum and globule of mercury, which would be absolutely sure to close every second, might be entirely overcome by having the mercury pure and making sure of good connections; that the difference between commercial and pure mercury was a very marked one in this case. Mr. J. A. Brashear of Pittsburgh called attention to the growing importance of chronographic records in all employment of men and machinery, and described a very perfect system in use in some manufactories. Professor Newton referred to the very convenient system of the Repsolds, for printing rapidly the settings of micrometer-screws, as well illustrated upon the new Yale college heliometer in charge of Dr. Elkin. Prof. C. S. Peirce of the coast survey called attention to the great gain this would be in recording the readings of micrometer screws in the comparison of standards of length where rapidity was highly desirable, and especially the avoidance of the necessity of removing the eye continually from the eye-piece to read off the head. Professor Paul alluded to his hope of soon applying Repsold's apparatus where rapidity was of the first importance; viz., in recording the settings of the position-circle of the Nicol-prism in Professor Pickering's method of observing the eclipses of Jupiter's satellites, where as many settings as possible are wanted while the satellite is entering or leaving the shadow; and he said he hoped, with a chronograph-key in one hand, and managing the Nicol and its printer with the other, to be able to secure the record of the times and settings of the Nicol-circle every two or three seconds, working entirely in the dark, and keeping it up as long as desired.

The next paper, by Prof. J. Burkitt Webb, described a method of using polar coördinates, by transferring the origin from the centre to the end of the unit-radius, — thus substituting $(r-1)$ for r,— and then using the length of the arc and the distance out from its end upon the radius vector, as x and y are used in rectangular coördinates. He found this a very convenient transformation in the application of polar coördinates to the discussion of Amsler's planimeter; and pointing out that by substituting infinity for unit-radius in the equations thus transformed, they were reduced to those of rectangular coördinates, he thought this transformation of polar coördinates might be found generally useful.

The only paper on Monday was a presentation by Mr. C. H. Rockwell of Tarrytown, N.Y., of some results of his observations for time and latitude with the almucantar, an instrument devised by Mr. Chandler of the Harvard-college observatory a year or two ago, which promises at least to furnish an entirely new and radically different method of attacking the question of absolute positions of the stars, and very probably far to surpass all others in accuracy, on account of its freedom from systematic errors. The results thus far published by Mr. Chandler seem fully to confirm all that was expected of the instrument; and it is probably not too much to say, that it is the most important addition of the present century to the instruments and methods used in the determination of absolute star-positions. The sources of systematic error would seem to be almost wholly reduced to those of varying personal equation in the observation of transits at all speeds, and at all inclinations and directions over horizontal wires, and to possible systematic difference in atmospheric refraction in different azimuths. Mr. Rockwell exhibited some results, simply copied from his observing-books, illustrating the methods of reduction for time and latitude observations, and showing the degree of accuracy that can be attained by the instrument in both these directions. They served to show that the instrument when duplicated will give equally good results with the one first constructed; and their consideration gave rise to a very interesting discussion, participated in by many members, as to the character of work the instrument might be expected to do, in the course of which Mr. Rockwell answered, in a very entertaining way, many questions, put by various members, as to the details of observing and reducing, which were not before clearly understood on account of the novelty of the work. One of the most important problems which the instrument is specially adapted to investigate, and one which we hope Mr. Chandler will soon find time to undertake, is the determination of the declination of fundamental stars south of the equator, tying them to northern stars at corresponding zenith distances below the pole. This would seem to be by far the best, perhaps the only, method of connecting these together in a way that shall be free from systematic error.

PROCEEDINGS OF THE SECTION OF PHYSICS.

THE first paper read before the section of physics was by Prof. S. P. Langley, on the spectra of some sources of invisible radiations, and on the recognition of hitherto unmeasured wave-lengths. The measurement of infra red wave-lengths has heretofore been confined to those found within the range of the solar-heat spectrum. It is of interest to know whether there are other wave-lengths than those found in the sun's heat, so that we may perhaps explain how it is that the surface heat of one planet is maintained in spite of the ready radiations of extreme solar heat through the atmosphere. Our knowledge of wave-lengths is comparatively recent, as Fraunhofer gave the first accurate measures in 1823. His range of values was from .00036 to .00075 of a millimetre. The use of the florescent eye-piece and photography has extended the range. The extreme range of the normal eye is from about .00036 to .00081 of a millimetre, or a little over one octave. It has been known since the time of the first Herschel, that heat radiations existed below the range of vision; but it was supposed that glass absorbed this dark heat. In 1881 Professor Langley found that common glass was diathermanous to all the dark rays which come to us

from the sun, and he has determined the wave-lengths of a newly discovered solar region by direct observation. We have in this infra red portion of the sun spectrum the greater part of the heat which sustains organic matter on this planet; and the questions arise, Does the planet radiate heat of the wave-lengths that it receives from the sun; and How is its temperature maintained, probably several hundred degrees above the temperature of space, when our observations show that the direct radiations of heat from the sun can only raise it about fifty degrees above the surrounding temperature? Experiments at Alleghany show that the dark solar heat is transmitted by our atmosphere with less difficulty than the light; and if the radiations of the soil are of this wave-length, our planet should actually be cooler on account of its atmosphere than if it had none. With this in view, Professor Langley has carried on during the last two years measurements of the radiations from bodies of the temperature of our earth. Almost the only material which can be used for the prism and lenses in this work is rock-salt. It is needless to say that the polish deteriorates after a few hours' use, necessitating a constant resetting of the surface. Leslie cubes covered with lampblack, and filled with boiling water or aniline, were used as radiating surfaces. Nearly the whole heat spectrum from these sources passed through the prism at angles which the theories of our text-books have heretofore pronounced impossible. Speaking with reserve, Professor Langley says that we have every reason to believe that heat radiated by the soil has a wave-length twenty times that of the lowest visible line of the solar spectrum. Professor Langley's results are of interest to the physicist, as showing that the wave-lengths of something more than one two-thousandth of an inch are rendered highly probable; to the astronomer, because we find that the heat radiated from the soil is of a totally different quality from that received from the sun; so that the important processes by which the high surface temperature of the planet are maintained, can now be investigated with, we may hope, fruitful results.

Much of the success of Professor Langley's work depended on the possibility of making satisfactory lenses and prisms from rock-salt. Professor Langley's paper was followed by one by Mr. J. A. Brashear, on a practical of method working rock-salt surfaces for optical purposes. Mr. George Clark succeeded in making and polishing a rock-salt prism for Professor Langley, but otherwise none had met with success; and Professor Langley was assured by the best opticians, that a rock-salt prism could not be made to show the Fraunhofer lines. Mr. Brashear proved this prediction to be false. Mr. Brashear's method consisted in the use of a pitch bed, which, while yet soft, was flattened by a plate of glass; the pitch was then cooled by water, and upon it were drilled conical holes one-quarter inch in diameter, and half an inch apart; the surface of pitch was then warmed suitably, and upon it was pressed a true plain surface. Upon the polisher thus prepared was put a very small quantity of rouge and water. The polishing was done by diametrical strokes, the operator walking about the polisher as he rubbed; this motion must be constant and continued till the last traces of moisture disappear, and the prism is to be slipped off the polisher in a perfectly horizontal direction.

Prof. H. S. Carhart presented a paper on surface transmission of electrical discharges, which was an ingenious revision of work by Professor Henry. Prof. E. L. Nichols presented some further notes on the chemical behavior of magnetic iron, a continuation of work described in a paper at the Philadelphia meeting. In the absence of Professor William Ferrel, his paper on psychometry was read by title only. Major H. E. Alvord of Mountainville, New York, presented the results of telemetric observations at Houghton Farm. This is a method by which changes in temperature are transmitted and recorded electrically; and Major Alvord's results show that, with increasing experience, the records followed more and more satisfactorily the observations made on the mercurial thermometer.

Commander Theodore F. Jewell's paper on the apparent resistance of a body of air to a change of shape, described some experiments at the U. S. torpedo station, in which a disk of gun-cotton was exploded on a metal plate. Upon each disk of the explosive had been stamped the letters 'U. S. N.', and the year in which the material had been manufactured. After explosion upon the iron, similar indentations were found upon the plate as if the air in the indented letters had been driven into the plate.

Professor T. C. Mendenhall called attention to the modifications and improvements already made or desired in electrometers, especially with reference to their use in observations on atmospheric electricity. Observations of this kind have been made regularly for the last year or two; but, as Professor Mendenhall well said, the meaning of the variations recorded is still a mystery. Prof. A. E. Dolbear read three papers: in one he described a method of studying the contact-theory of electricity by means of the telephone. He has found that a click is produced in the telephone every time the circuit is broken between two heterogeneous materials, as copper and zinc. In another paper he referred to his success in employing a Bernstein incandescent lamp for projection purposes; and in the third he described a new galvanic element of high electro-motive force and great constancy, consisting of carbon in a saturated solution of bichromate of potash and sulphuric acid, and zinc in a saturated solution of ammonic chloride; nitric acid could be used in place of sulphuric. Mr. A. J. Rogers presented a paper on electrolysis of the salts of the alkaline earth.

It is much to be regretted that Prof. J. Burkitt Webb was obliged, by want of time, to refer so unsatisfactorily to his papers on entropy and the life of the universe, in each of which he presumably discussed matters in the interest of thermodynamics.

Prof. E. L. Nichols has, by means of a spectro-photometer described at a previous meeting, compared the spectrum of the unclouded sky with that of the light

reflected by magnesium carbonate, illuminated by direct sunlight. Repeated measurements of the relative intensities of corresponding portions of these spectra throughout their whole length, and similar comparisons of the spectrum of the magnesium carbonate with the direct spectrum of the source of illumination, have furnished data from which the character of the light sent us from the open sky can be determined, and, in one sense, its color also. The measurements show that the spectrum of the sky is of the same character as that of white light, varying less from the reflection spectrum of a perfectly colorless object than do the spectra of such substances as white paper, sulphate of calcium, carbonate of magnesium, lamp-black, etc. Similar measurements were made of the reflection spectra of Lord Rayleigh's 'blue cloud,' formed by the precipitation of sulphur by hydrochloric acid in a solution of hyposulphite of sodium, and of thin films of antimony oxide. It was found that the same is true of the light reflected by these substances. The blue color of the sky and of other opalescent media is, according to these results, not due to an excess of the more refrangible rays in the light reflected by them, but is of subjective character. This view the author has maintained in a previous paper, in which it was pointed out that a well-known peculiarity of the eye, its rapidly increasing sensitiveness to violet, with decrease of intensity of illumination, is sufficient to account for the appearance of the sky, and of many other objects, without having recourse to the hypothesis of selective reflection. The object of the present paper is the presentation of experimental evidence bearing upon this question. It is to be regretted that Prof. S. P. Langley had left town before this paper was read. A number of those present called attention to the disagreement of the results of Professor Nichols with those obtained by Professor Langley.

Professor Nichols's paper was appropriately followed by that of Prof. C. K. Wead, who exhibited a combined spectro-photometer and ophthalmospectroscope. This instrument, made by the Geneva society, is intended to combine with the least possible duplication of parts, several of the best instruments for the study of spectra. It gives the measure of the relative brightness of the spectra: 1°, by the width of slits or by smoked glasses; 2°, by Nicol prisms outside the collimator; 3°, by combination of the two. Further, it allows: 1°, the mixture of any two spectral colors in any relative intensity, and their comparison with an intermediate spectral color by 'Donder's coupled slits;' 2°, the addition of either the simple or the mixed color of a measured quantity of white light (Glan); 3°, the comparison of the simple or mixed colors of the spectrum with the light from a colored body.

In a paper on weather changes of long period, Mr. H. Helm Clayton of Ann Arbor cited evidence that there are at times slow progressive movements of barometric change, and of temperature from west to east. Mr. Clayton also made an attempt to show a certain periodicity in the character of the weather of the United States during the last year, and claimed to be able to make predictions based on this periodicity for a month in advance. The paper excited considerable adverse criticism.

Two papers by Dr. J. W. Moore of Easton, Penn., were devoted to an explanation of apparatus for classroom demonstration of electrodynamic phenomena. A paper read by Prof. H. W. Eaton of Louisville, on the relation of vanishing and permanent magnetism, contained results of an investigation which he had undertaken at the suggestion of Wiedemann.

Prof. C. J. Reed of Burlington, Io., exhibited a piece of apparatus for classroom demonstration of the laws of falling bodies.

CHEMISTRY IN THE SERVICE OF PUBLIC HEALTH. [1]

IN the study of hygiene from the chemical side, we are obliged to consider not only the normal conditions of the earth and atmosphere, but the changes which are brought about by the crowding together of individuals on account of the pursuit of manufacturing industries.

In the service of sanitary science, chemistry has an educational office to fill. The public has very little conception of what the capabilities and limitations of chemistry are. It is hard to make a person believe that water to be analyzed must be brought in a clean vessel, and that the chemist cannot distinguish between the impurities of the water and those of the jug. It is almost impossible for the chemically uneducated public to understand that when chemical action takes place, the properties of the substances concerned are not carried into the product; that because vitriol is used in glucose factories the product does not contain the acid; and the use of aquafortis in making oleomargarine, is equally startling.

There must needs be reformers and philanthropists, but many of these are extremists; and nowhere, more than in sanitary matters, is a little knowledge a dangerous thing. At one time all the evils were attributable to microbes, and at another to sewer-gas. Microbes may be left to the biologists, and possibly sewer-gas as well, since chemists have failed to discover any substances in the gas which could produce the well-known ill effects. In the matter of food adulteration, the origin of the terror is often obvious; thus, that tea is said to be adulterated with prussic acid, arose from the use of Prussian blue in the facing. Chemists are periodically obliged to distinguish between adulterations which are merely falsifications and those which are harmful, and it must be remembered that even the purest commercial products contain small amounts of foreign substances.

It is, perhaps, not altogether to our credit that we so often need the spur of extravagance to lead us to

[1] Abstract of an address delivered before the section of chemistry of the American association for the advancement of science, at Ann Arbor, Aug. 26, by Prof. W. R. NICHOLS, of the Massachusetts institute of technology, Boston, vice-president of the section.

lay before the public the truth with regard to existing evils. An unvarnished statement of things as they really are, cannot awaken that interest which arises when people imagine, after each meal, that they feel the effects of the alum in the bread, or the burning of the vitriol in the glucose adulterated sugar, or the heavy weight of the clay out of which the coffee-berries were moulded. It is certainly an important service to public health, that of investigating the actual state of existing evils; and noble examples of such service are seen in the investigations by the *Lancet* of food sold in London. Another point where chemistry comes advantageously in contact with the public health, is in the suggestion of practical remedies for existing evils: some seem to believe that the proper method is, in all cases, to ascertain the existence of the offence, and then to order its discontinuance; but generally, where the evil has been long growing, and where our pecuniary interests are involved, such summary legislation is, as a rule, unjust.

Lavoisier, Berthollet, and, in more recent times, Frankland and others, have interested themselves in the application of chemistry to sanitary purposes; but Pettenkoffer and Angus Smith have been specially prominent workers in this line. This list shows that able chemists have been willing to devote their time to sanitary chemistry; but how often it is the case, that a brief course in analysis is held to justify a person in acting as an adviser, as the state assayer or public analyst!

Professor Nichols stated that he had been asked, What is sanitary chemistry? Is it any thing more than puttering? as if the problems were all solved, and we had but to follow a mechanical process. Our knowledge of the normal composition of the atmosphere rests upon the analysis of many chemists; but, while we know so much, who knows the bearing upon health of the variations to which the atmosphere is subject? How much, in spite of the work of Professor Remsen, do you know of the organic matter in the air, and the proper methods for its dedetection and estimation? Professor Remsen and others have found that the passage of carbon monoxide through the heated iron of our furnaces is practically of no account; but who can tell us of the composition and amount of the gaseous 'somethings' which make the anthracite-heated atmosphere of our houses so different from that of a house heated by a wood-furnace? It is asserted by some that the day of chemical examinations is passing away, and that the wholesomeness of water will be determined by the biologist, not by the chemist. Without detracting from the present value of biological methods, we cannot believe that they can replace chemical examination for a long time yet: it must first become certain that all the evil effects of impure water are due to the organisms now so eagerly studied. When the biological examination of water has been placed on a firm basis, it will then be necessary to carry out the work begun by Professor Mallet, of discovering the chemical characteristics which belong to waters which a biological examination condemns, and of making these characteristics the basis of future chemical analysis. In the matter of the pollution of streams by sewage, there is much chemical work to be done. The natural purification of streams is admitted to be a fact; but chemists differ as to the extent to which it takes place, and the agencies at work. The action of oxygen has been and is to-day being studied; but clear light will not be obtained so long as we are content to speak of 'organic matter' as though it were a definite something.

Sanitary science comes nearest to the public in the examination of foods and drinks. Chemical examination of such substances has long been provided for by law, and in recent years has seen greatly increased activity. Provision is made on the continent of Europe for such examinations; and there are laboratories at the service of the public, either gratis, or under a tariff often ridiculously low. In this country, more or less stringent laws against adulteration exist; and these laws, in some states, have been made more stringent on account of popular feeling, which was at its height in 1878 and 1879; but the enforcement of such laws is usually in the hands of the state boards of health, which are often hampered by the want of suitable appropriations. As far as Professor Nichols was informed, no laboratories have been established by states or municipalities, where the public can have analyses made either gratis, or for a moderate fee; and it is doubtful how far the establishment of such laboratories is desirable. The laboratories which exist in connection with various educational institutions are probably all that is needed; and there are advantages in securing the co-operation of a number of able chemists, as is done in New York State, and in assigning to each certain descriptions of articles for analysis.

Investigations in sanitary chemistry have been undertaken in the various agricultural and physiological laboratories; but one of the first — if not the first laboratory founded for the investigation of these questions — was that established in Dresden, in January, 1871, under the direction of Dr. Fleck. Among subjects investigated at this institution, were the various methods of water and food analysis, methods of protecting combustible and inflammable material, and the effect of arsenical papers upon the air of rooms. The state board of health of Massachusetts led the way on this side of the water, and the earlier reports of the board contain many papers on similar questions.

The education of those who propose to follow this line of work requires a thorough knowledge of general and analytical chemistry, and of physics. It is quite possible to take a bright lad from the grammar school, or even from the street, and teach him to make analytical determinations with great accuracy; but this does not make a chemist of him. Courses in sanitary engineering in our technical schools have been established, but how far these courses will develop does not yet appear. In order that the student may have an intelligent idea of what questions should be submitted to the chemist, and how the results obtained should be understood, he should

have a good knowledge of the principles of chemistry. Sanitary inspectors should be familiar with certain chemical tests which would enable them to make preliminary examinations, and to determine how far the aid of the chemist is necessary. There is room in the community for a class of persons knowing a little engineering, a little chemistry, a little biology, and a little of other things, an occupation legitimate and honorable, but one which does not justify our calling a person so posted a sanitary engineer, or a chemist.

PROCEEDINGS OF THE SECTION OF CHEMISTRY.

THE meeting of the chemical section had an unusually large attendance; and Ann Arbor, not having very many attractions to withdraw the attention of members, allowed all chemists in attendance to be present. The total number of papers presented was small, — in all only seventeen. Of these one was not chemical, one was every thing, one organic, one applied, two mathematical, two pharmaceutical, three theoretical, and six analytical. The meeting, while not brilliant, was respectable, and was remarkable chiefly for the absence of the older and more renowned chemists of the country. It would certainly be an advantage if these would more generally endeavor to attend the meetings of the association, and encourage the younger members by their counsel. Following is a brief synopsis of the more important papers presented: —

Prof. A. B. Prescott gave results of experiments made under his direction, fixing the limits of recovery of certain poisons when mixed with organic matter, such as meat and bread.

Prof. W. A. Noyes read a paper on para-nitrobenzoic sulphunide. This body belongs to the class of sulphunides, the first representative of which was discovered by Fahlberg. The new substance is remarkable, in that it retains the imide grouping peculiar to the sulphunides in its salts. This nitrosulphunide is intensely bitter, while benzoic sulphunide is probably the sweetest substance known.

Dr. H. W. Wiley presented a method of estimating lactic and acetic acids in sour milk or koumiss. The caseine is precipitated by adding an equal volume of strong alcohol to the milk. After filtering, the acid is determined in the filtrate, using phenyl-phthalein as indicator. The same author spoke of the composition of koumiss made from cow's milk. The analyses show a lower percentage of alcohol and lactic acid, and a higher one of milk-sugar and fat, than are found in European samples, whether made from cow or mare's milk. The adulteration of honey was also discussed by Dr. Wiley. The honeys of commerce are found to be largely adulterated. The substances most used for this purpose are, starch-sugar sirup (glucose), cane-sugar, and inverted cane-sugar. Results of numerous analyses made at the department of agriculture were given, and a comparison of American honeys made with those of Europe.

Messrs. H. W. Wiley and F. V. Broadbent described a new method of estimating water in glucose, honeys, etc. Samples are dissolved in alcohol mixed with a weighed portion of sand, and dried. After cooling to 70° C, they are saturated with absolute alcohol, and dried again to constant weight.

Messrs. E. H. Cowles, A. H. Cowles, and C. F. Mabery, presented an important and interesting paper on a new electric furnace, and aluminum alloys made in it. The furnace is of fire-clay. The mass to be acted on is mixed intimately with finely-powdered gas-carbon, and is placed in the break between the two electrodes, which are inserted in the two ends of the furnace, and connected with a powerful dynamo-electric machine. The mass to be reduced is surrounded with coarsely pulverized charcoal, to prevent the heat produced from attacking the fire-clay furnace. The temperature of the furnace is high enough to produce an alloy of copper and aluminum, when the aluminum is present in the state of oxide, or even of silicate. The aluminum alloys produced by this method cost much less than when made in the old way. The five per cent aluminum alloy is a close approximation in color to 18 carat gold, and does not readily tarnish. Its tensile strength, in the form of castings, is equivalent to a strain of 68,000 lbs. to the square inch. An alloy containing two or three per cent aluminum is stronger than brass, possesses great permanency of color, and would make an excellent substitute for that metal. The effect of silicon in the small portions, upon copper, is to greatly increase its tensile strength; and copper and silicon alloys are made easily in the furnace. When more than five per cent of silicon is present, the product is extremely brittle. Alloys of copper and boron have also been made. Boron seems to act upon copper as carbon does on iron. A small percentage of boron in copper increases its tensile strength to 50,000 or 60,000 lbs. per square inch, without diminishing to any great extent its conductivity. Aluminum seems to increase very considerably the strength of metals with which it is alloyed. An alloy of copper, nickel, and zinc, containing a small percentage of aluminum, has been named 'Hercules metal,' and withstood a strain of 105,000 lbs. to the square inch. The strength of common brass is doubled by the addition of two to three per cent of aluminum. Alloys of aluminum and iron are obtained, without difficulty, in the furnace. One product was analyzed containing forty per cent of aluminum.

A chemical study of Yucca angustifolia was presented by Miss Helen C. D. Abbott. Besides many of the usual constituents found in plants, the following were detected: manganese in the ash, four fixed oils, a new resin which it is proposed to name yuccal, another new resin which it is proposed to name pyrophaeal, a red crystalline coloring matter, a new gum, four crystalline compounds, and saponin. In

the subterranean part of the yucca the oil extracted from the bark is solid at ordinary temperatures; from the wood it is of a less solid consistency, while the yellow base of the leaf contains an oil quite soft; and in the green leaf the oil is still more fluid. Yuccal was obtained from the bark and wood of the root. It is a transparent ruby-colored substance, melts at 70° C, and its specific gravity is 1.091. A blood-red color reaction was obtained by warming the resin with ammonium molybdate, and a few drops of strong nitric acid. Pyrophaeal was extracted from the yellow base of the leaf, and melts at 79° C. The amount of saponin obtained in the wood varied from 8.95 per cent to 10.4 per cent. Saponin was also found in the bark and leaves of the plant.

Prof. F. P. Dunnington described a method of fixing crayon drawings. The drawings made on unsized manila paper are saturated with a preparation consisting of one part Damar varnish, and twenty-five parts turpentine. After drying, they are ready for use. A paper by the same author describes a peculiar porous mineral containing titanic acid, found on a steep mountain side, and evidently of igneous origin. The surrounding soil was found also to contain titanic acid. The origin of the mass is somewhat uncertain.

Mr. O. C. Johnson presented a paper on negative bonds, and a rule for balancing equations. After giving rules for determining bonds, the author presented his views of simple oxidation, oxidation with combination, double oxidation and complex oxidation in their relations to chemical equations.

Mr. A. V. E. Young presented a study of the thermo-chemical reaction between potassic hydrate and common alum. After describing the experiments which had been made, the following conclusions were reached: 1°. That if potassic hydrate in excess be added to alum, there results a characteristic distribution of constituents between the soluble and insoluble portions of the mixture. 2°. This distribution is a function of temperature, as well as of dilution and mass. 3°. This phenomenon is probably due to dissociation by water of compounds Al_2O_3, and SO_3, and of potassic aluminate.

Prof. J. W. Langley read a paper on the results of an investigation of the concentration produced by the differential action of chemism on certain acid radicles. The paper showed, that, by this action (as for instance when a copper plate is suspended in solution of argentic nitrate), the NO_3 divided into two parts, having an approximate ratio of 1:3. Copper and zinc in aqueous bromine behave in the same way. Copper in solution of ferric chloride, and zinc in solution of copper sulphate, produce a concentration of the radicle in opposition to gravitation.

By communication with the various members of the section, the secretary had arranged the following question for discussion: What is the best initiatory work for students entering upon laboratory practice?

Dr. H. W. Wiley was requested to open the discussion. He said it was with laboratory work largely as Pope said about governments, 'What's best administered is best.' Students beginning laboratory work should understand at once that chemical science is no guess-work, but a science of definite proportions. They should learn the use of the balance, and their experimental work in general chemistry should be conducted quantitatively from the start. Students should be taught to rely upon themselves: their faculties of observation and powers of reason should be developed. At first they should be kept as much as possible from books, and from too garrulous professors. They should be told nothing of the physical and chemical properties of a body, which, by proper diligence, and under wise direction, they might find out for themselves. For instance, in studying hydrogen, the student should be directed to take definite quantities of zinc and sulphuric acid, to measure the volume of gas given off, to dry and weigh the residual zinc sulphate, and study its properties, etc. Whether beginning students should be kept at work in the study of general chemistry, or be taught also analytical work, will depend largely upon the judgment and taste of the instructor. Laboratory work, in order to give its full benefit, must be combined with lectures and recitations: and through it all, the work illustrating stoichiometry must be fully done and comprehended. The progress of the work should be gauged neither for the dullest nor brightest pupil, but the middle course will be found best. In all cases, much will depend on the judicious oversight and guidance of the instructor.

Prof. R. B. Warder asked whether it were better to begin with gases or with metals? He was inclined to prefer metals, since their properties were more easily discovered. Prof. F. P. Dunnington suggested a course of metallurgy and assaying as being well adapted to a student's initial laboratory work; afterwards the use of the blow-pipe could be introduced. Mr. Thos. Antisell said that the object of instruction ought to be considered in determining its character. If the study of chemistry was begun only as a part of a liberal education, the course of instruction should be largely qualitative analytical work. On the other hand, if the pupil was looking forward to chemistry as a profession, it would be better to put him to quantitative work.

Prof. A. B. Prescott was impressed with the idea that the study of chemistry might be approached in two ways; viz., as descriptive chemistry, and, experimentally, in general chemistry. Students should, in analytical work, practice first on known bodies before beginning on unknowns. Care must be taken not to place too much reliance on laboratory work alone. It is of the utmost importance that rigid class-work in the lecture and recitation rooms go along with the experimental work in the laboratory. As great a mistake may be made by relying on laboratory work alone as there was formerly by neglecting it altogether.

Prof. C. F. Mabery regretted that chemistry was not taught practically in high schools and academies. School trustees generally thought that seventy-five dollars a year was a liberal allowance for laboratory purposes. He would have young people begin with common phenomena, such as the rusting of iron, etc.

He would insist on his pupils mastering the principles of stoichiometry, and in working, as far as possible, quantitatively, even in general chemistry. Mr. C. L. Mees heartily indorsed the ideas advanced by Professor Mabery. For three hundred dollars, a good practical chemical laboratory could be established in high schools, which, if properly conducted, would result in great good. He would insist on a student repeating his work until it was exact. No careless work should be allowed. Mr. C. W. Kolbe gave an illustration of high-school instruction in chemistry, which was evidently purely bookish. The young man who had passed a brilliant examination in stoichiometry failed to do the simplest kind of a problem afterwards, because, he said, 'it was not in the book.' Miss L. J. Martin thought chemistry should be taught in high schools so as to make the pupils think, and not become mere machines. Prof. O. C. Johnson gave an amusing account of the failure to develop the sense perceptions, which he thought should be an important part of laboratory instruction. Messrs. Bennett, Sheppard, Smith, and the acting vice-president, Lupton, also took part in the discussion.

The second subject discussed was, 'To what extent is the knowledge of molecular physics necessary for one who would teach theoretical chemistry?

Prof. J. W. Langley was invited to open the discussion on this topic. He gave a very clear and satisfactory exposition of the dependence of chemistry upon physics, and of their close relation to one another. He drew attention to the fact, that only under fixed or limited ranges of physical conditions do the ordinarily accepted reactions and chemical affinities manifest themselves. Professors Prescott and Lupton took part in the discussion, showing the advisability of delaying any attempts to teach the higher branches of physics until the student had advanced well in practical laboratory work.

THE SECOND LAW OF THERMODYNAMICS.[1]

THE second law of thermodynamics has been chosen for the subject of this address: what that law is will be the main question, and the ground will be taken that Rankine's view of the subject is the correct one. After calling attention to the statements of Tait and others as to this law, and as to Rankine's way of stating it, no apology will be necessary for the choice of a question which ought already to have been fully and satisfactorily settled.

There are three different statements, each claiming to be the second law of thermodynamics. I. Rankine's law: "If the total actual heat of a homogeneous and uniformly hot substance be conceived to be divided into any number of equal parts, the effects of those parts in causing work to be performed are equal." Rankine gives also a second form of the law, in which the expression 'absolute temperate' takes the place of 'total actual heat.' II. Clausius gives as the 'Second fundamental principle,' "Heat cannot of itself flow from a colder to a warmer body." This may be a law in the general theory of heat, but not in thermodynamics, which treats of the relations between heat and mechanical energy; and it has nothing to do with Rankine's law, except as all natural phenomena may be connected. III. The formula for the maximum efficiency of a heat-engine is given as the second law, but this is only a consequence of that law, and the form of the engine.

It would seem from this variety of statement, that a law of nature might be any thing to suit our purpose. I think, however, that a careful examination of Rankine's second law will show that it is genuine, and that it is not universally quoted only because it is not understood. Rankine's law is either copied *verbatim*, or modified in a way to make this evident; and I must confess, that, before working upon the subject myself, I had difficulty with Rankine's statements: they seem now, however, so reasonable, that I shall endeavor to lead you to the same opinion.

Let us see now what is most natural and appropriate for a second law: the first law states that heat and work are mutually convertible, and convertible in a fixed ratio; and it is appropriate that the second law should state the agency by which such conversion may be accomplished, and the rate at which it may be effected.

A quantity of heat, W', may be employed as an instrument for the conversion of another quantity of heat, W, into work, or for the conversion of a quantity of work, A, into heat; and the converted quantity will be proportional to the converter quantity for a given change of volume or of entropy.

To realize the truth of this statement, let us imagine the simplest physical air-engine: we need no fly-wheel, valves, etc., but simply a vertical cylinder of infinite height, and unit section, with non-conducting walls, the bottom permeable to heat, and the non-conducting piston loaded with a pressure varying so as to be always equal to the gaseous pressure beneath it.

But this is no more than the shell of the engine: we will suppose the piston at such a point that the cylinder shall have a volume of one cubic unit; and we must now put in it, say, one unit of mass of the molecules of a perfect gas, resting on the bottom as dust, or distributed through the space as in any gas, but devoid of motion: we have now added the muscles, but they are dead flesh; the engine is not capable of transforming heat into work, or *vice versa*. The agent by which such a transformation may be accomplished is not present; the space through which the piston may move exists, but the molecules exert no pressure against the piston, and there can be no question of work until we have both space and pressure. To obtain this necessary pressure we must heat the gas to the absolute temperature, τ; i.e., we must store in the molecules an amount of kinetic energy propor-

[1] Abstract of an address delivered before the section of mechanical science of the American association for the advancement of science, at Ann Arbor, Aug. 26, by Prof. J. BURKITT WEBB of Ithaca, N.Y., vice-president of the section. For the complete address, see *Van Nostrand's eng. mag.*, October, 1885.

tional to τ; and calculation shows us that the pressure, which they will then produce by rebounding from the piston, will be proportional to this amount. It will also, for any increased volume, be inversely proportional to that volume. In the ordinary formula connecting the volume pressure and temperature of a perfect gas, $pv=R\tau$, we have only to suitably change the value of R to be able to write $pv=R'W'$ where W' is the converter quantity of energy referred to in the law, which we have stored up in the molecules to act as the agent or instrument for the conversion of heat into work, or *vice versa.*

We wish to emphasize this point, — just as the animal cannot perform its functions without life, so it is this stored-up energy which is the real agent in the engine. Rankine says, "The effect of the presence in a substance of a quantity of actual energy in causing transformation of energy, is the sum of the effects of all its parts." Here he distinctly represents energy as the agent for the transformation of energy.

I believe that nothing but energy can thus act, and that the general law underlying transformations of energy may perhaps be thus stated: "Every conversion of energy from a form A into a form B can be effected only through the agency of a quantity of energy," (and I venture to add) and this agent or converter quantity must possess at once the characteristics of A and B.

In the engine the agent possesses temperature and pressure, — the characteristics of heat and work: in the dynamo the field is characterized by both electrical and mechanical tension.

Now our agent-quantity of heat must act without expense to itself, for this is the peculiarity of agents; therefore the expansion must be isothermal: a source of heat at the temperature $\tau + d\tau$ being applied to the conducting bottom, the gas will then expand without loss of energy from the volume unity to the volume v, thereby converting a quantity of heat into work, which will be infinite for an infinite volume. For any given change of volume, the amount of work will be proportional to the pressure; that is, to the amount of agent-energy: so that for such a change the truth of the law is seen.

Let us look now at the behavior of the molecules: as each rebounds from the hot bottom, its stock of agent-energy receives into itself a portion of the heat W which is to be converted into work; i.e., the molecule is driven away with an increased velocity by the hotter molecules of the bottom; it carries this portion to the piston, to which it gives it up in the form of work, because if the piston be moving with a velocity V, the molecule will rebound from it with its velocity reduced by $2\ V$. As the volume increases, the pressure must fall, on account of the rebounds becoming less frequent, and the heat will be converted into work more slowly; but for any and all particular changes of volume, the rate of conversion will be in proportion to the amount of agent-energy, and, therefore, to the temperature of the gas. It is interesting, also, to notice that the distance (from the bottom to the piston), over which the heat-energy W must be carried, increases directly with the volume; and therefore the time required to carry a certain amount will be proportionately increased, the only way to obtain a more rapid conversion being evidently to increase the velocity of the molecules; i.e. the amount of agent-energy.

Let us turn now to Rankine: he is most easily understood if we commence with his 'general law for the transformation of energy,' already quoted, and proceed backward; and we come first to a graphical representation of the second law. After explaining the quantities in his diagram, and the known relations between them, he asks us to suppose the temperature τ to be divided into n equal parts. Should this supposition be difficult to make, we have only to remember that τ is the temperature of the agent, and, therefore, the amount of agent-energy in terms of a suitable unit; in fact, the statement that a unit mass of gas possesses a temperature τ, is equivalent to saying that it possesses τ units of energy, the unit being the energy required to raise this amount of gas one degree in temperature. We are to suppose, then, the agent-energy divided into n equal parts; and we are afterward told that these parts are 'similar and similarly circumstanced.' Now let us suppose a molecule, at the temperature $\tau=0$, to be heated to the temperature τ by the addition of n equal increments of energy; once added, all distinction between these parts vanishes, and there remains only the conception of the whole amount of energy as consisting necessarily of n smaller amounts; and the effects of all these amounts will be the same, and the sum of their effects the effect of the whole. It is only upon the thermometer-scale that degrees of temperature have special places, and that the last one added, and the first subtracted, must be the top one: we cannot, however, see any way in which the energy last added must be the same as the first subtracted.

In Rankine's graphical treatment he shows isothermal expansion; and it should be emphasized that it is the only expansion suitable for the conversion of heat into work, or *vice versa.* With adiabatic expansion we have nothing to do: its only use is to alter the amount of agent-energy, and it need not be used until we come to engines working in a cycle.

Rankine's next statement of his law is the second one criticised by Maxwell, and it supposes nothing more than the division of the absolute temperature already discussed. The first formula should, however, read

$$\tau \frac{d}{d\tau} = Q \frac{d}{dQ}.$$

Proceeding backward, we come to a seemingly more general and comprehensible statement of the law, which speaks of 'the total actual heat.' Now, Rankine has, I think, sufficiently defined this; and it is simply the kinetic energy of the molecules, or that portion of the heat furnished which remains as heat.

Inasmuch as the first statement of the law seems more general, insomuch has it led, as I believe, to a false comprehension of its meaning. It may seem more general in this way: —

Let x, in a system of rectangular coördinates, represent mass, and y absolute temperature, then the area, xy, will be proportional to the energy, or, with a suitable unit of temperature, will equal it. Now, we may cut this area into n equal parts by vertical lines, which will also cut the mass into n equal parts. In such case it requires no scientific imagination to see that these parts are similar and 'similarly circumstanced;' but this is altogether too simple for the use to be made of it, and no such statement can pass for a law of thermodynamics; it is simply the law of homogeneousness.

Rankine leads up to his statement in an unfortunate way, perhaps, emphasizing the fact that every particle is equally hot. Well, so it must be, or the upper line of the figure would not exist, or would be curved, which would interfere with the argument, because there would then be no one temperature for all the molecules. But Rankine intended no such vertical subdivision: in fact, he says, 'Let unity of weight,' etc.; and we may take a differential unit, and so put such a division out of the question. The division intended by Rankine was by horizontal lines, which makes the statement of the law identical with the other: only he says here, 'heat;' and there, 'temperature;' and he commences with heat, because heat is energy, and changes to temperature, because temperature is the practical way of estimating this energy, and is proportional to it.

We believe, then, that this is the one and only second law; and as our agent is a quantity of energy, and as energy resides in mass, whereas different substances do not differ in their mass, therefore the particular working substance used has no effect.

We will now look again at the formula for efficiency, which flows directly from Rankine's law, in a simple and evident manner.

If we could make an infinite-cylinder engine, this formula would not be needed. This engine works *at* a temperature, not *between* two temperatures, and it transforms all the heat into work. But mechanical considerations require us to build engines that run in cycles, and we then need it. Every engine running in a cycle is a double engine, consisting of an engine proper and a condenser; i.e., while the piston rises in the cylinder, which we cannot make infinitely high, we transform heat into work completely: then we must use our engine as a condenser for recompressing the gas; and, while doing so, we transform work completely into heat; and if we lower the temperature of the gas before compressing it, there remains a margin of work, according to the efficiency formula.

It should be remarked, that we have made no special reference in this address to any thing but a perfect-gas engine; and we believe the theory of this should be made clear before introducing the necessary modifications to include liquids and solids: Rankine has, however, framed his formula to cover both. Many other points have been left untouched; but if I have made plainer how heat, and therefore temperature, may be supposed to consist of any number of equal parts, and convinced you that Rankine's is the real and only second law, my main object will have been accomplished.

PROCEEDINGS OF THE SECTION OF MECHANICAL SCIENCE.

THE valuable work done by a few in this section deserves the special recognition and support of all its members. The four divisions under which this work may be classified, embrace wide and interesting fields of thought and study. These divisions are, Technical education, Accurate standards of measurement, General, scientific and practical engineering work, and Original investigation. These are proper lines of work for the advancement of 'mechanical science and engineering,' because they include the education of men for the work; the production of instruments and appliances suited to the work; excite enthusiasm, and diffuse knowledge, among the workers; and enlarge the realm subjected to the exact knowledge and control of the intellect and will of man.

The first paper read before this section was on the strength of stay-bolts in boilers, and gave an account of experiments by the writer, Mr. L. S. Randolph. These experiments were designed to furnish data for the explanation of the peculiar manner in which the stay-bolts between the fire-box and boiler-shell had been found to break. The theory was, that the extreme difference of temperature liable to occur between the parallel plates — being at times 200° F., — caused a shifting of these plates, parallel to one another, sufficient to bend the stay-bolts considerably; and that this bending, occurring near the surface of the plate into which the bolt is screwed, caused the bolts to break at this point. The amount of such bending having been calculated from the known difference of temperature and the length of the plates, the experiments showed that if similar stay-bolts were subjected to this amount of bending, they would ultimately break, thus, apparently, confirming the theory. In the discussion, different forms of bolts or stays were suggested as likely to remedy the difficulty. The adoption of a link in place of a bolt was thought to be impracticable in this case on account of the small distance between the plates. Proportioning the stays so as to enable them to bend under the stress to which they are subjected without reaching the elastic limit of the material, was suggested as a remedy for the difficulty. It was shown that stays are sometimes worn away by being vibrated or bent. This bending causes the scale which has been formed to be thrown off; and oxidation occurring again under the action of the water, this new scale is thrown off, and this process continued wears away or 'channels' the iron.

A short abstract of a paper on a universal form of pressure-motor by Prof. D. P. Todd was presented by

the secretary. The abstract enumerated the advantages of the arrangement of multiple radial cylinders, the pistons of which act upon the inside of a vibrating eccentric. In the discussion, several novel forms of this kind of motor were recalled, as having been used or tried; but it was shown, that thus far the advantages claimed had not usually been sufficient to counteract the objection of complicated construction. Being best adapted for slow speeds, these motors are not economical for steam on account of excessive cylinder condensation.

The subject of the next paper, by Mr. Stephen S. Haight, was the use and value of accurate standards for surveyors' chains. The chain described was of flattened steel-wire, with thermometer attached to record temperature, a spring-balance to weigh the tension under which the chain is used, and a spirit-level. Professor Davis exhibited a tape, such as his experience had proved to be practical for ordinary work, and which, though not capable of so great accuracy, perhaps, as the one described by Mr. Haight, he had found amply so for general use in a large range of work in the state of Michigan. Professor Davis also exhibited a reel of simple construction. The president read some notes from Prof. W. A. Rogers, chairman of a committee on standards of measurement. These notes contained one suggestion relating to greater precision in the use of calipers. As shops are coming more into the practice of having tool-rooms, Professor Rogers proposes to have a comparator in the tool-room of each shop, and to have the calipers sent to this room to be nicely set to exact size, thus eliminating the errors so sure to exist under the ordinary methods. The fact, that some metals and alloys when subjected to change of temperature do not return to their original volume when the normal temperature is restored, was mentioned as a possible cause of variation in standard measures, and fault of adjustment in instruments of precision made of such metals. Iron does not show this property of a 'set' in the ordinary range of temperature within which such instruments are used. The committee on accurate standards was continued for another year.

A short paper by Prof. J. B. Webb, on the lathe as an instrument of precision, called attenion to the lack in most lathes of that exactness of construction required to give a lathe the 'fine sense' of precision which some instruments possess, so that it is usually a machine for the economic removal of metal, rather than for the production of exact forms. There is at present no uniform method or available apparatus by which a purchaser may test the degree of error in any given lathe. Some simple methods for making such tests were briefly described. Another paper by the same author, on the economy of accurate standards, set forth the increased money-value of such articles as machine-bolts, screws, etc., when nicely fitted by accurate standards.

A paper by Mr. C. J. H. Woodbury, on the coefficient of efflux of automatic sprinklers, described these sprinklers, which are devices for extinguishing fires. The sprinklers are attached to pipes, and the water is automatically let on to the sprinklers by the melting of solder under the action of heat caused by the fire. It often happens that the pipes conveying the water to the sprinklers are too small to deliver the required volume of water. The paper gave the results of the author's experiments for determining the coefficient of efflux, and the formula for discharge of automatic sprinklers attached to commercial fittings; also the means of determining the number of sprinklers on given pipes, which will make the losses due to friction approximately equal, and not so great as to impair the efficiency of the apparatus. In the discussion, various methods of preventing the freezing of the water in winter were described, a simple one being to fill the exposed pipes with compressed air. This involves careful fitting of joints and valve-stems. This has been done so successfully as to show a loss of only two pounds' pressure per week from leakage. Where an air-tight tank is used, the compressed air may fill the space above the water in the tank as well as the exposed pipes. In this case, there need be no valve or mechanism between the tank and the sprinkler; and when the passage to the sprinkler is automatically opened, the air in the pipe first rushes out, followed by the water which is forced out by the pressure of the air in the tank.

Mr. Frank C. Wagner presented an elaborate paper on electric-light tests, giving an account of his work in testing the efficiency of two electric-light plants.

Prof. M. E. Cooley explained and illustrated a method of testing indicator-springs. The method consists in placing a small rigid rod in a vertical position, with its lower end resting upon a standard-scale. Upon the upper end of the rod, the under side of the piston of the indicator rests. The indicator is fastened to a horizontal bar movable on vertical guides. When this bar is pressed down by means of thumb-screws upon the guide-rods, the pressure on the piston, and, consequently, on the spring of the indicator, can be weighed upon the scales, and the position of the pencil recorded by a mark upon the card. Experiments made when the spring was heated nearly to 212°, showed that the resistance of a sixty-pound spring was diminished about one pound by change of temperature. Professor Cooley also explained a new smoke-burning device, consisting of a rectangular slot through each door of the furnace, just above the level of the hot coals, and two three-eighths of an inch steam-pipes entering the furnace above the doors, and so directed that a jet of steam passing through them strikes the fire about two feet back of the door. As the air passes in through the slots, and over the live coals, it becomes heated; and when it meets the steam-jets, is thoroughly mixed with the products of combustion, and completely oxidizes them. The only condition requiring careful attention is that live coals shall be kept at the front of the furnace, and nearly on a level with the slots in the doors.

In a paper entitled 'Deep water at Galveston, Tex., and how to secure it,' Dr. Alexander Hogg advocated the construction of a break-water extending out two miles from the shore as the best solution of the problem. From the discussion, it

appeared that the ocean-bed at that coast is a shifting quick-sand, and some doubt prevailed as to the practicability of such a structure at any reasonable cost.

Prof. R. H. Thurston's paper on cylinder condensation was of great scientific and practical value. The fact, the manner, and the effect of condensation in steam-cylinders, were made clear, even to those but little acquainted with the subject. Nearly all the losses met with in steam-engines are due to this cause. Watt found that three-fourths of the steam used in his engine was lost by condensation. In ordinary engines of modern construction, about twenty-five per cent is the usual loss; while in some large engines this loss has been reduced to ten or fifteen per cent. This waste depends upon the temperature of the surface of the cylinder when the steam enters, the temperature of this surface when the steam is exhausted, the extent of surface exposed, and the time of a revolution of the engine. These four variable elements bear different relations to each other in different engines operating under unlike conditions. The engineer has at present no means of designing an engine for given conditions for which he can calculate just what will be the waste, due to condensation from these causes. The complete solution of the problem requires that experiments be made, first, to ascertain the variation of loss due to a change of one of these quantities, all the others remaining constant, and that the law of such variation be mathematically expressed. A second of these variables is treated in the same manner; and so on until the law of variation of loss, due to change in each one of these variables, has been expressed. Then, if it be possible to combine all these results into a single formula, this formula will express the complete theory, and give the full solution of the problem. These experiments were made with a Harris-Corliss engine, capable of developing over five hundred horse-power. The engine was controlled by a large brake constructed for this purpose. Curves were plotted, representing the results of the different series of experiments recorded. While the full solution of the problem undertaken may involve the necessity of further experiments, the results tabulated in this paper will prove of great value to engineers. The paper will soon be in print.

A description of the large Prony-brake used in the experiments just referred to, formed the subject of a short paper by the same author. The size of this brake, and the extraordinary requirements made upon it, viz., that of transforming five-hundred horse-power of mechanical energy into heat, and giving up this heat with sufficient rapidity to prevent the undue heating of the machine, were the principal features of the device.

The discussion on the best methods of teaching mechanical engineering was opened by the report of a committee, through Prof. J. B. Webb its chairman, who alluded to the discussion of the same subject by the Society of mechanical engineers at Atlantic City. That discussion showed that engineers desire that technical schools shall give thorough preparation in theory and principles; and, also, that they insist upon the importance of such practical knowledge and skill — in all who are to direct men, and plan and execute work — as will enable the foreman or engineer to instruct, direct, and, if necessary, show his men how to do their work.

Prof. R. H. Thurston said that the training should be adapted to the work to be done. Therefore he favored classification into manual training-schools, schools of mechanic arts, and schools of engineering. A large proportion of the students who start at the beginning of the course will prove fitted to become workmen only, and may go from the manual training-school into a special course for some particular trade, or into the shop. Of the remainder, some will be able to do construction and simple designing, and might go from the school of mechanical arts into a special course preparing them for superintendents and directors of workmen. A few will have ability to become engineers; and should have, not only manual training and the mechanic arts, but, in addition, an unusually good knowledge of mathematics, applied mechanics, physics, including electricity, and some chemistry. Mechanical engineering requires a better knowledge of the physical sciences than any other profession. The higher a man goes, the better must be his knowledge of the use of tools. Teachers of engineering should be men who have had good training through a broad practical experience in the solution of engineering problems, and should have retained their theoretical knowledge by reading and study. Such men, at present, are rarely found.

Further discussion brought out the suggestions, that there are no manual training-schools where a boy can learn a trade before entering the higher schools; that the St. Louis and Chicago manual training-schools will not make workmen, and that probably not five per cent of their students will ever become workmen. These schools are appendices to the public schools, to give a general training by a different method. Technical schools try to crowd too much into four years. Principles should be taught upon which the man can build for himself. Men must know how to think, and they will be able to learn engineering. Practice is theory embodied; and, in so far as practical experience or work can aid theory, the two should be intimately mixed or blended from first to last. Manual training aids the judgment. Shop-work, interspersed with classical studies, would not diminish proficiency, and would add a valuable element. Shop-work at Michigan university is offered to all students, and is often elected by others than those studying engineering. Actual shop-work, too, is an efficient 'conceit killer.' More liberal preparation should be required for admission to technical schools. The important feature of the discussion was the advocacy of courses of study, leading one into the other, with natural stopping-places, each of which is a starting-point for some special trade, position or profession, adapted to the talent and ability of the individual student.

PROBLEMS IN THE STUDY OF COAL, WITH A SKETCH OF RECENT PROGRESS IN GEOLOGY.[1]

WE have again assembled in our annual council, to renew and extend our acquaintance with each other, to maintain and strengthen the *esprit de corps* which ought to characterize the workers in a common field, to share with each other the new facts and new conclusions that we have reached by the labors of the last year, *mente et malleo*, and especially to aid each other in securing larger and more symmetrical views of the truths we hold, by fraternal discussion, criticism, and correction.

To review the record of the last year, and gather up its most significant advances, would be appropriate to the occasion; but various limitations forbid me to undertake such a task in any formal way. Before entering, however, upon the discussion of the subject which I wish to present to you, I beg leave to call your attention to a few facts that seem to me of special interest; and also to point out, in like cursory manner, some of the special directions and subjects in which American geology seems to me to be showing the most activity and progress at the present time.

The history of the vertebrate life of the globe, as far as it is now written, indisputably owes some of its most interesting and important chapters to American geology; but up to the last year we were still obliged to recognize the Ludlow rocks of Great Britain as the depositories of its earliest known forms. The recent fortunate discovery of the pteraspidian type of fishes in the Onondaga group of central Pennsylvania, by our associate, Prof. E. W. Claypole, has, however, granted us an equal date, at least, with the Scaphaspis of the lower Ludlow; and a fair argument can be made as to the somewhat greater antiquity of the Pennsylvania forms. This argument it is not necessary to press; for it loses its point and interest in the light of Professor Claypole's subsequent discovery of well-marked scales and spines of fishes in the iron sandstone of the middle Clinton group of central Pennsylvania. Onchus Clintoni of Claypole must enjoy the distinction, at least for a little time, of being recorded as the earliest representative of the vertebrate life of the globe.

But the 'earliest vertebrate' always sits on a precarious throne. At any moment the title is liable to lapse. To see its horizon suddenly descend several thousand feet in the scale, scarcely awakens our surprise. The abrupt appearance, the great numbers and the comparatively high organization of the earliest American fishes heretofore known, all demand a long antecedent history; and it is therefore no unwelcome labor to erase the old boundaries, and to draw the new ones, in such a way as to gain protracted ages for the unfolding and development of the type.

Another fact in the history of vertebrate life, acquired during the past year, deserves special mention here. Mr. Samuel Garman has recently published a description of a living shark that proves to be a cladodont, and so nearly allied to the genus Cladodus of carboniferous time, that it might with little violence be referred thereto. According to present knowledge, the family of cladodonts originated in the middle Devonian; and the genus Cladodus, as we have hitherto been obliged to hold, became extinct in the same age that gave it birth: but the chance-catch of a Japanese fisherman gives us an unmistakable cladodont, if not a true Cladodus, to-day; and in it we find 'the oldest living type of vertebrates.' The gap is far wider than any that has been heretofore bridged.

The discovery during the last year of fossil scorpions in three quite widely separated portions of the world at horizons approximately identical, and at the same time vastly lower than any in which they had been found hitherto, is a fact of much geological interest and significance. These three specimens from the upper Silurian effect an immense extension of the history of the tribe to which they belong, but each of them still falls short of the title of the 'earliest known land-animal.' That distinction is, for the present, held by the representative of an allied division. From well-characterized strata of middle Silurian age in central France, there was obtained during the past year the fragment of a cockroach's wing. It is a surprise to find Blatta, for the time being, at the head of the line of the inhabitants of the dry land.

Within the last year our associate, Mr. C. D. Walcott, has published a description of two species of pulmoniferous mollusks from the lower portion of the carboniferous rocks of Nevada. Both belong to the aquatic section of the Pulmonifera, and constitute the sole known representatives of that group in paleozoic time. One of them is a true Physa, and thus gives to this humble form a vast antiquity.

But leaving, without further notice, these very suggestive facts, let us barely glance, in passing, at some of the chief features in the advance of geological knowledge among us at the present time.

In the first place, stratigraphical geology appears to me to be attaining a somewhat juster recognition than has hitherto prevailed. It has been made very clear, that the work of the paleontologist is still too incomplete to allow any off-hand settlement of many of the questions that arise, by his determinations. There has been, in my judgment, an undue tendency to settle all questions as to the age and order of the several strata of any considerable series by the testimony of a few fossils. In the second place, the growing use of the microscope in geology is to be noted as one of the directions in which progress is apparent and marked. There is scarcely a field of research in which the service of the thin section is not now acknowledged and invoked. By it most of the varied claimants to the early life of the globe must be tried; and by it, as well, the minerals of the igneous and metamorphic rocks must be finally determined. Let us glance next with equal brevity at two

[1] Abstract of an address delivered before the section of geology and geography of the American association for the advancement of science, at Ann Arbor, Aug. 26, by Professor EDWARD ORTON, State geologist of Ohio, vice-president of the section.

or three of the fields of American geology in which special activity now prevails.

I have already called your attention to the beginnings of vertebrate life on this continent, but it is not in this fact that the chief interest of our vertebrate geology is found. It is in the later stages and higher forms of vertebrate life that American geology holds an easy and undisputed pre-eminence. Along the eastern slopes of the Rocky Mountains, there are being disentombed the remnants of great faunas of cretaceous and tertiary time that are quite without parallel in the history of geology. While these faunas are remarkable for the great number and variety of the species and individuals, and also for the enormous size of some of their forms, it is in other directions that their highest interest lies. By their anomalous and altogether unexpected characters, by their strange combination and dissociation of peculiarities of structure, they throw a flood of light on the question of evolution, and give us a key to the development of the existing creation that, before their discovery, it was too much to expect that we should ever possess. Here are birds with teeth, here are reptiles without them. Here are animals in which the characters of both birds and reptiles are so blended that it is hard to tell on which side of the line they belong, or whether there is any line. Here are horses with four toes, and hogs that chew the cud.

The activity in the investigation of the so-called archaean rocks is 'known and read of all men;' but as to the progress to be reported I dare not affirm, for the smoke of battle still covers the field, and the clash of arms still fills the air. In no previous year has there been so large and varied an amount of publication upon all of the problems involved as in this; and the topics discussed cover the whole range, from the igneous fusion of the earth, to the formation of a recent volcanic cone. The discussions are characterized by great ability, but the conclusions reached are wide apart and irreconcilable. Eozoön still maintains the struggle for existence, but with apparently lessening chances of survival.

Glacial geology is still a field of decided activity and progress. The most recent of geological formations, the drift, is still the most anomalous and perplexing. We have less experience and direct observation that can be brought to bear on its mode of formation, than we have on oceanic deposits, or even on the outflows of igneous vents. But, little by little, we seem to be coming into substantial accord in regard to the general sequence of the events that constituted the glacial period. The luminous and fruitful theories of Croll, like Darwinism in biology, are permeating all our modern glacial literature.

The most important service that has been rendered in the American field is the recent mapping of the great moraine from the Atlantic border to Dakota. And in view of the facts which have thus been brought out, scepticism in regard to the former occupation of the northern portions of the continent by a sheet of land-ice moving southward would seem to be impossible to the candid mind. It is coming to appear that the glacial record of North America is, like the rest of its geological history, incomparably simpler and clearer than that of Europe; and both the order of events of the last ice-age, and the nature and mode of operation of the forces employed, can be studied to better advantage here than elsewhere in the world.

I wish now to bring before you a few of the *Unfinished problems relating to the geology and chemistry of coal.*

For the last fifty years, there has been no reasonable ground for doubt that coal is more or less metamorphosed vegetation, and that the plants which formed the coal grew where they are now found. Nearly every seam of coal is underlaid by a stratum of clay containing the well-known stigmaria, which have been proved to be the roots, or underground stems, of the lepidodendrid and sigillarid trees composing the coal; and hence it may be truly said that the rootlets of the stigmaria bind the coal-seams fast to the surface of the land. Most of the well-matured and more elaborate theories of coal agree still farther in holding that this vegetation grew on low lands, and not only near the sea-level, but near the sea itself. But as we advance beyond these generally accepted positions, we seem to find ourselves at once among the unsettled questions; for the particular conditions and modes of growth of the great sheets of coal vegetation are variously conceived and represented.

1°. Forests growing on swampy tracts, finally submerged, and buried under sheets of sand and clay, the forest trees themselves constituting the bulk of the coal: this is one of the earlier and cruder theories which it is somewhat surprising to find still surviving. 2°. An accumulation of vegetation, quite after the manner of the mangrove swamps of sub-tropical lands at the present time, makes another theory. Geikie adopts this as the best picture of the conditions of coal formation that we can find in the existing order of things. 3°. By Sir Charles Lyell, the cypress swamps of the lower Mississippi were made to do like service. 4°. Fifty years ago Brongniart made the suggestion, in an almost incidental way, that we should find in the peat-bogs of to-day the analogue and representative of the coal-seams. This suggestion has been living and growing ever since. A young Swiss naturalist was perhaps the first to expand it into a definite theory. He saw that the laws of the peat-bog could be applied to the coal-seam; that the only key to the history of the latter was to be found in the beds of fuel that are growing now, but whose roots go back into past millenniums. We should have had a glacier theory of the drift without Agassiz, a scientific geography without Guyot, and, in like manner, the peat-bog theory of coal would have found its way here without Lesquereux; but, historically, it fell to these three illustrious compatriots, fellow-students, and life-long friends, to lead the way, each in his own field, to these several great advances.

I have glanced at the problem of the coal-swamp, and the accumulation of a single seam; but these seams are combined in great systems with beds of

sandstone, conglomerate, shale, limestone, and iron-ore, to a thickness of hundreds and thousands of feet. We are confronted, then, with the problem of a *coal-field*, and bring to our interpretation of it the points already made; viz., that every seam was formed by vegetable growth in a swamp or bog near the sea-level. Subsidence of the coal-forming area must be invoked, and the swamps successively buried under marine sediments.

To see what some of the problems of a coal-field are, let us take a concrete case. The coal-field of eastern Ohio is by far the most orderly field that has ever been described. The regularity and simplicity of its structure make it the type for this whole class of formations. What, then, do we find in this, the simplest and most symmetrical, the least disturbed and complicated, of all known coal-fields? We find a maximum of two thousand feet of strata covering ten thousand square miles. There is a well marked rhythmical order of arrangement of these strata. The three kinds that represent the agency of life are always found in close proximity. Coal standing for the life of the land, limestone for the life of the sea, iron-ore, equally dependent on life for its separation and concentration, but blended with both limestone and coal, these form vital nodes in the series, relatively of small amount, but containing all the economic interest and value. The nodes are separated by the sandstone and shale, which are barren of life, and owe their accumulation to inorganic forces. Measured against the products of life, these inorganic sediments have a thickness of five or ten feet to one. But note, the intervals between the vital nodes are approximately equal. Turning now to the problems presented by this typical field, how can we explain the regularity of these intervals? One suggestion of an explanation is found in that unique contribution to modern science, Croll's 'Climate and time;' viz., that the carboniferous age was a period of high eccentricity, and that the coal-seams were formed during interglacial stages, — an astronomical cause for the recurrence of these cycles of life, that exhibit an almost astronomical rhythm and order, this is a light in a dark place, albeit the light is thus far but a feeble one.

But more important questions yet remain, involving the extent and reach of the several seams, and the laws of growth of the field as a whole. Were the lowest coal-seams formed over the entire area? and may we expect their presence in the central portions of the basin, if we descend deep enough? These questions, and others of like import, must be classed as open, although certain general propositions which it would be a pleasure to expand compel me to believe that they should not be answered in the affirmative.

On the chemical side, there are various unsettled questions pertaining to coal, some of which possess both theoretical and practical interest. But, although they are probably not insoluble, science must sink its roots deeper before it can give us full answers. The microscopic structure of coal is another field in which much remains to be done. It is what has been already done in this direction that gives us our grounds of confidence in regard to the vegetable origin of coal. But the relative importance and distinguishing characters of coals formed of carbonized vegetable tissue, of spores, and of hydrocarbons, are still undetermined.

In conclusion, we may be sure that the problems relating to coal which now rise before us as unfinished, will, sooner or later, find their solution. But when they are solved, will all be known? Nay, verily. Out of these old carboniferous swamps, new questions, larger, deeper, than any we now see, will perpetually arise to stimulate by their discovery, and to reward by their solution, that *love of knowledge for its own sake* which makes us men.

PROCEEDINGS OF THE SECTION OF GEOLOGY AND GEOGRAPHY.

THE section opened with the *éclat* of a masterly address by its chairman, and was continued with lively interest, and a fair attendance, which abated only on the last day of the session. Twenty-seven papers were read, and nearly all of those elicited appreciative and profitable discussion. Debate was never unduly warm, and, though full, rarely wandered from the text. The proper functions of the association were evenly exercised; all ideas were freely criticised; the isolated and retiring student was encouraged; the chronic talker was merciful; and the philosopher, who had evolved from his consciousness a perfect theory of the universe, was persuaded to defer its promulgation. In the distribution of the communications by topics, stratigraphy received the lion's share, rejoicing not only in the leading number of contributions, but in the most important paper of the session. The age of ice claimed less attention than usual, and the mysteries of the archaean were unassayed. The following summary of the proceedings, abandoning the order of sequence of the meeting, gives first place to the earth's crust as a whole, follows with its successive layers from lowest to highest, and closes with volcanism and mineralogy. Geography made no contribution to the programme of the section; but it furnished the only paper accepted by the association for presentation to the general meeting, — a lecture by Capt. E. L. Corthell, on the interoceanic problem, the substance of which has already appeared in *Science*.

When, in his celebrated essay, George Darwin deduced from the tidal retardation of the earth's rotation the theorem, that the ellipticity of the terrestrial figure has been diminished throughout geologic time, he omitted to make certain deductions in regard to

the earths' crust, — deductions by no means plain to the physicist who maintains the solidity of the globe, but scarcely avoidable by those who conceive of the solid crust as thin. Two Americans have independently complemented his theory in this respect, and it happened that their arguments were both submitted to the association. Professor Alexander Winchell presented a paper on the sources of trend and crustal surplusage in mountain structure; and, to his great surprise, was followed by the reading of a communication from Mr. William B. Taylor, on a probable cause of the shrinkage of the earth's crust, in which his treatment of surplusage was so closely duplicated that a single abstract may serve for both. Accepting the demonstration by Dutton and Fisher of the quantitative insufficiency of the so-called 'contractional hypothesis' of crust corrugation, and following Darwin in his conclusion that geologic time has witnessed a notable shortening of the equatorial diameter, and a corresponding lengthening of the polar, these gentlemen find in the change of figure a 'surplusage' and consequent 'shrinkage' of the crust. The readjustment of the crust to the less flattened spheroid involved not only a diminution of its area, but the institution of a system of shearing and other strains, calculated to wrinkle the surface in all parts except the polar regions; and to produce, what is actually observed, — a maximum effect within the zone of the equatorial bulge. The remaining half of Professor Winchell's paper, found in the lunar tidal influence an independent reason for the prevailing meridional trend of corrugations. He saw in the lagging of the tide a force tending to slip the tidal crust westward; and this would result, during the ages of crust formation, in an ingrained meridional structure, which would in turn determine the trend of subsequent folds consequent on surplusage.

Three discoveries of fossils were announced in what has been disputed ground at the base of the geologic column. Prof. N. H. Winchell brought from the pipestone-quarry of Minnesota a contorted trilobite of the Paradoxides type, and slabs of sandstone covered with round phosphatic brachiopods referred provisionally to Lingula. From these he inferred the pre-Potsdam and post-Huronian age of a great series of rocks in Minnesota and Wisconsin, including the cupriferous rocks of Lake Superior. Prof. William B. Dwight reported the discovery of a unique Potsdam locality one mile north-west of Vassar college, and in the Wappinger limestone belt. Among the fossils are Lingula primiformis, Lingula minima, Obolella, Conocephalites, and Dicellocephalus. A contribution was made to the veteran Taconic question by Prof. James D. Dana, who exhibited lower Silurian fossils taken at Canaan, N.Y., from the 'sparry limestone' of Emmons, a member of his original Taconic system as first defined by him in 1842. A short discussion followed, in which Professor James Hall said that the existence of Silurian fossils in these rocks was claimed and admitted forty years ago; and Prof. N. H. Winchell argued that Emmons's later use of the title Taconic, in which he applied it to certain rocks in New York, now known to be pre-Silurian, entitle the name to a place in stratigraphic nomenclature.

Professor Edward Orton described the gas and oil wells of north-western Ohio, dwelling especially on their contribution to stratigraphy. The district, as at present known, centres at Findlay, where the first success was achieved. The borings start in the water-lime and Niagara formations, quite below the Berea grit, the only rock from which the geologist would have ventured a year ago to predict a supply of gas. The exploration was incited by superficial indications, — the occurrence of gas in springs, superficial wells, etc., in the vicinity of Findlay. The flow of gas ranges in different wells from 100,000 to 1,200,000 cubic feet per day. The petroleum, which is not afforded in great amount, is black, sulphurous, and of about 35° gravity, — a description applying to all oils from limestones. The descending section, compiled from several well records, includes 275′ of Niagara limestone, 2′ to 6′ of Niagara shale, 30′ to 40′ of calcareous shale (Clinton), 200′ of red shale (Medina), 300′ to 400′ of calcareous shale (recognized by its fossils as Hudson River), 250′ to 275′ of brown shale with fossils (Utica), and 500′ of porous magnesian limestone identified as Trenton. This bears the gas and oil. One matter of note is, that the Hudson River and Utica groups of New York, which in southern Ohio are called 'Cincinnati' because they cannot be separated, are here individually recognized. Another is, that the Cincinnati arch, as illustrated by the attitude of the Trenton, lies farther west in northern Ohio than has been supposed. Its trend is nearly north-south.

The paper which commanded most attention was that of Prof. Henry S. Williams. While no single element of his method is novel, his work must nevertheless be recognized as a new departure; for none of our geologists have heretofore pursued comparative stratigraphy, and the comparative study of faunas, in so close combination, and in such detail. As the importance of the work will command for it, in the pages of *Science*, a fuller analysis than the necessary limits of this report permit, the present notice will be confined to an account of its scope and method. The area studied comprises the southern counties of New York, the adjoining counties of Pennsylvania, and northern Ohio as far as Cleveland. In this area numerous sections were studied, extending from the termination of the Hamilton group in the Genesee shale through the upper Devonian, and terminating upward with the conglomerate underlying the carboniferous. The examination of the sections extended to minute stratigraphic details; and the fossils from each stratum were kept separate, it being found that in rock series, involving alternations of beds lithologically different, there are usually corresponding alternations of distinct faunas. A failure to attend to this principle leads to the mingling of faunas, and consequent misconception; its recognition makes of each fauna an identifiable unit, which can be traced in its geographic distribution, and its successional development. It appears, for example, that the fauna of the black Genesee shale is repeated in every higher black shale of the column; and that, in its successive recur-

rences, it exhibits an orderly series of modifications which are parallel in different sections. Though its record is discontinuous at any one locality, the life of the fauna was continuous somewhere, its distribution at every epoch being determined by ever-shifting physical conditions. Within the field of study are seven distinct faunas: *A*, the middle Devonian, or general Hamilton, fauna; *B*, the fauna of the black shales; *C*, the fauna of the green shales of the Portage group; *D*, the fauna of the brown shales and sandstones of the Chemung group; *E*, the fauna of the Panama conglomerate; *F*, the fauna of the Catskill rocks; *G*, the fauna of the Waverly group. In each of these, except *E* and *F*, from three to seven variations are recognized, which have a successional order, and are designated 'stages.' In presenting his material, Professor Williams defined each stage, and assigned it a symbol, consisting of a letter and a number. A chart exhibited the local stratigraphic columns drawn to scale, and in their proper geographic relations, lithologic distinctions being expressed by colors, and the faunal horizons indicated by their symbols, — a system of graphic presentation which greatly aided the audience in comprehending the author's numerous inductions.

Prof. S. G. Williams reported observations on the shore of Cayuga Lake, at the outlet of Skaneateles Lake, and at Oriskany Falls, leading to the conclusion that lower Helderberg rocks, other than those of the water-lime group, have a greater westward extension in New York than has heretofore been supposed. Prof. James Hall called attention to the uniformity of conditions indicated by the stratigraphic series in central New York, as compared with the varied history deducible from the exposures on the Hudson River; and Prof. J. P. Lesley spoke of the 'infinite variability' of the Oriskany. Pennsylvania contains a thousand miles of its outcrop, in which its thickness oscillates from five hundred feet to nothing at all; and no two sections agree. Mr. A. S. Tiffany gave an account of the corniferous group as it is exhibited in Scott county, Iowa, and in Rock-Island, Ill.; and also of a yellow sandstone at Burlington, Io., which he refers, with doubt, to the Chemung. From the first he reported 246 species of fossils, and from the second 84 species.

The problem of the origin of the paleozoic sediments of Pennsylvania was discussed by Prof. E. W. Claypole. Postulating that the material came from a belt of Archaean rocks now exposed — or known to underlie later formations — in south-eastern Pennsylvania, and adjacent portions of New Jersey and Maryland, he based a computation on the area and known thickness of the sediments, and the area of the assumed district of derivation; and reached the conclusion that the Archaean district had suffered a denudation of several vertical miles. Then, restricting attention to the conglomerates of the paleozoic area, he showed, that, on a moderate estimate, 36,000 square miles of sediment contain an average of thirty feet of vitreous, milky quartz, in the form of pebbles. In the rounding of these by attrition, a still greater quantity of quartz was disposed of; so that a truly immense amount must have existed in the district of denudation. The visible Archaean outcrops contain only a small amount of such quartz, and that is almost confined to a narrow belt of Huronian rocks in Pennsylania. It is probable, therefore, that the Huronian was better represented in the eroded mass of Archaean than it is in the surviving outcrops.

Prof. Lewis E. Hicks described the structure and relation of the Dakota group in Nebraska, maintaining that the actual eastern shore of the Dakota Sea is there recorded. The formation rests on an eroded surface of subcarboniferous limestone, the valleys of which were occupied by bays and gulfs of the Dakota Sea. It is noteworthy that the lines of post-carboniferous drainage were identical with the main lines of modern drainage, though the streams flowed in the opposite direction. It thus happens, that, despite the westerly dip, the eastern boundary of the Dakota has its salients in the east-sloping valleys of the existing topography. The average thickness of the formation is 400 feet: its average dip is six feet to the mile in the direction N. 70° W. It is not entirely, nor even predominantly, composed of sandstone, but contains a large amount of shale, with fire-clays, and, near the top, some lignite.

The first communication on the drift was the opening paper of the session, and introduced to the attention of the section the features of the local geology. As the phenomena Prof. A. Winchell described have long since passed into geologic literature, they need not be recited here; but he touched on a local economic subject which is well worthy of promulgation. Citizens of Ann Arbor have culled from the fields the larger crystalline erratics; and, breaking them into suitable shape, have built of them their finest edifices, public and private. The stones exhibit a variety and individuality which no quarry can rival; but the prevailing flesh-tints and grays blend harmoniously, and the effect is peculiarly agreeable to the eye. Prof. A. H. Worthen described the quaternary deposits of central and southern Illinois, taking for his text the sections afforded by a number of coal-shafts traversing the superficial deposits. The bed-rock surface is diversified by valleys very much as is the drift-surface above, but with a different drainage system. The drift-section is, therefore, variable in thickness, but the sequence of its members is approximately uniform. At bottom is a stratified clay, in part gravelly; and, as judged by its composition, this is derived from the waste or decay of the bed-rock of the immediate vicinity. Then comes a forest-bed — not a universal feature, but so widely spread as to render the well-water of large districts unfit for use. Over this lies a blue and yellow gravelly clay, with glaciated bowlders ranging up to two feet in diameter; then a few feet of loess, and finally a thin bed of fine clay. These deposits do not point to glacial ice alone as an agent. They indicate water also, and the lowest member is either sedimentary or alluvial. Prof. John C. Branner gave an account of the glaciation of the Lackawanna valley, where the same rock-surfaces bear striae in systems diverging from 20° to 40,° and in one instance even 120°. These are

explained by the consideration, that, when the great ice sheet was most extended, its local depth was great as compared to the height of the mountain ridges, and it traversed them obliquely with little or no deflection; but, as its extent and depth diminished, it yielded more and more to the control of the topography. Prof. E. W. Claypole pointed out, that, granting this explanation, a strong argument was afforded against the theory that ice is a great agent of erosion. If the erosion of the later epoch was too feeble to efface the scratches left by the earlier, we cannot reasonably regard the earlier erosion as great. Mr. William McAdams, who last year exhibited bones from the loess at Alton, Ill., announced further discoveries of the same nature, and described the superficial deposits of the region. The list of species now includes mastodon, ox, deer, megalonyx, beaver of several species, gopher, ground-hog, bear, and an animal allied to the wolf.

A phase of post-glacial geology was treated by Mr. G. K. Gilbert, who has recently traced an old shore-line of Lake Ontario half way about its basin. From Hamilton, Can., to Sodus, N.Y., it runs parallel to the modern shore. It then turns southward, and deviously outlines a great bay, studded with islands, which occupied the basin of the Oswego River and its branches from Lyons to Rome, and sent a narrow arm to Cayuga Lake. East of Lake Ontario it is once more parallel to the modern shore. The outlet was then at Rome, and the discharge flowed down the Mohawk valley. The plane of the old water-surface is no longer horizontal, but inclines southward, with an average slope of about four feet to the mile, and westward more gently. At Adams Centre, in Jefferson county, it is 650′ above tide; on the north shore of Oneida Lake, 480′; along the Erie canal south of the lake, 430′; near Rochester, 423′; at Hamilton, 350′. It passes beneath the water of Cayuga Lake near its north end. Subsequent to the epoch of this shore-line, the water-surface of Lake Ontario was depressed below its present, as is shown by many of its bays, which occupy valleys wrought by post-glacial stream erosion. Mr. Gilbert's working hypothesis is, that the shore-mark associated with the Rome outlet records an epoch in which the retreating ice-sheet still occupied the St. Lawrence valley. The northern side of the basin was then relatively depressed; and when the water finally escaped past the ice at the north-east margin of the basin, its surface rapidly fell to a position below the present shore. The existing system of levels has been effected by subsequent crust movements.

A paper by Prof. Frederick D. Chester, on the gabbros and amphibolites of Delaware, was read by title, and will be published in the proceedings. Prof. A. R. Crandall gave an account of some small volcanic dikes, recently discovered in Elliot county, Kentucky. The surrounding strata lie nearly level, and the locality is about ninety miles north-west of the nearest Appalachian dislocation. The dikes do not impress their form on the topography, but have yielded to decay along with the enclosing carboniferous strata. Prof. L. E. Hicks remarked that he had observed on the White River in Nebraska a dike which resembles these, in that it is associated with no disturbance of the sedimentary rocks.

Mr. George F. Kunz briefly described a new mass of meteoric iron from Carlestown, W. Va., and read a series of notes on minerals from new localities, or otherwise interesting. Among them were native antimony from Prince William, N. B.; tourmaline from Rumford, Me.; a pseudomorph of felspar after leucite (?) from Magnet Cove, Ark.; a curious form of beryl from Auburn, Me.; a capped garnet from Raymond in the same state; and a turquoise from New Mexico, artificially stained to produce a favorite blue shade. He described, also, a collection of rough diamonds, temporarily in the possession of Messrs. Tiffany & Co., bringing out especially the fact, that the convex curves of some rough diamonds are not referable to attrition, since only the diamond can wear the diamond, but are made up of crystalline facets. A paper by Dr. T. Sterry Hunt, on the apatite deposits of the Laurentian rocks, was read by abstract.

EDUCATIONAL MUSEUMS OF VERTEBRATES.[1]

FROM what is known of man's present constitution and environment, and from what is commonly believed respecting his future form, condition, and associates, it seems to follow that all kinds and degrees of zoölogical instruction, whether anatomical, histological, physiological, pathological, psychological, or religious, should be based upon some knowledge of vertebrated animals. As aiding to make this knowledge real and lasting, every educational institution, of whatever grade, should have a vertebrate museum.

From many vertebrate collections the average visitor carries away, besides the sense of fatigue, certain impressions which are inadequate or erroneous, or, if correct, uncomplimentary.

The following plans and methods are followed in a preliminary re-arrangement of the vertebrate collections at Cornell university: The exhibition-cases should contain only specimens which can instruct or interest the visitor. Not only should facts be displayed, but fundamental principles should be illustrated. There should not only be special series of embryos, brains, hearts, etc., but such preparations should be associated, to a certain extent, with the animals to which they belong. Preparations illustrating important facts should retain so much of the entire animal as may facilitate recognition and association; when this is inconvenient, the preparation may be accompanied by a figure of the animal. When the relative rank of several forms is well determined, the lower or more generalized should be placed below or at the left, and the higher or more specialized

[1] Abstract of an address delivered before the section of biology of the American association for the advancement of science, at Ann Arbor, Aug. 26, by Dr. BURT G. WILDER of Cornell university, vice-president of the section.

above or at the right. As a rule, each specimen should teach but one thing, and that thoroughly. The same form may, therefore, properly recur in several parts of the museum, to illustrate different parts or ideas. Quality is more important than quantity, and arrangement is usually more needed than acquisition. True economy consists in paying liberally for what is wanted, rather than in taking what is not wanted as a gift. The usefulness of a specimen, and thus its real value, is to be measured, not by its rarity or cost, but by the degree in which it exemplifies important facts or ideas. Many specimens should not only be labelled, but also accompanied by figures and explanations.

In addition to, or more often in place of, the three great series — physiological, taxonomic, and geographical — which are commonly attempted in museums, but which it is rarely possible to complete, specimens representing an equal amount of time or money would have a higher educational value if divided among a considerable number of special series, each illustrating some morphological or teleological principle.

Some of these series are strictly artificial, yet useful; as, e.g., animals exterminated by man; those which supply us with food, medicine, weapons, clothing, or materials for habitation; fabulous, mythical, and sacred animals; and those which are mentioned by Shakespeare, and in the Scriptures.

Of natural series, the most conspicuous and complete should be the *vertebrate branch synopsis:* this should embrace, within a space easily covered by the eye, one stuffed example or model of a species representing each vertebrate class, together with four preparations exhibiting the vertebrate type of structure; viz., a transection of the whole body; a hemisection of the whole body; a complete vertebral segment; a hemisected skeleton showing the variation in size of the neural and haemal cavities. So far as possible, these preparations should be made from members of different orders of the class, and be accompanied by outline diagrams and explanations.

Each class, but first and especially the mammalian, should have its own special synoptic series, embracing one or more entire examples of each order, and preparations illustrating the characters of the class. The choice and arrangement of these preparations are complicated by the desirability of indicating that what are commonly enumerated as class characters are of unequal degree: some are constant and peculiar; some constant, but not peculiar; others peculiar, but not constant; and others, again, though usual, are neither peculiar nor constant. The neglect to indicate these differences in lectures, text-books, and museums gives rise to inaccuracy or uncertainty in the minds of students.

Instead of vainly attempting to obtain and exhibit all the species of all the groups, most educational museums would attain more satisfactory results by selecting the more interesting or instructive forms from all classes, and limiting their efforts to complete groups for a few, upon which, as well as upon a larger number, may be illustrated the principles of classification, and of individual and geographical variation.

Among special series other than systematic, are *analogous forms and structures* which are sometimes mistaken for one another, but more readily discriminated when brought together. Such series are the rostrated animals, spinous forms, and those which have parachutes. *Physiological series* would contain the hibernating animals, those which are blind or nearly so, and such as are provided with scent-glands, tusks, and all poisonous vertebrates.

A *local collection* should embrace all the animals of the vicinity, and will benefit the student, both as an example for him to follow or improve upon, and as exemplifying the laws of geographical distribution and the influence of environment. The local collection need not contain anatomical preparations, but should exhibit both sexes, and all stages of growth of each species, — its mode of life, friends and foes, — so as to interest also the children, farmers, fishermen, hunters, and other residents of the neighborhood.

Special attention should be called to existing deficiencies, not only in the local collection but in all parts of the museum; and graduates or other friends of the institution should be reminded of the opportunities, often peculiar, which they may have of supplying desiderata.

Although more than a quarter of a century has passed since the modern scientific doctrines respecting the methods of creation began to be accepted; although opposition to the general idea of organic evolution is now nearly confined to the stubborn and ill-informed; and although its substantial truth is tacitly admitted, or openly claimed, in nine out of ten higher educational institutions in this country, — I have yet to learn that any considerable part of a college museum has been specifically devoted to the exhibition of the facts which are described or figured in most zoölogical manuals, and in many works upon popular science.

Such a collection should embrace much more than a few ape-skeletons hung beside that of man. To avoid the appearance of dogmatism, let me briefly mention the various series relating to evolution which have been begun at Cornell university: Simple ontogenetic series, exemplifying the extent and rapidity of individual transformation; comparative ontogenetic series, illustrating the resemblance between successive stages of one form and the adult conditions of others; generalized, synthetic, or intermediate forms, or 'connecting links;' forms supposed to have degenerated; apparently useless or even hurtful organs or conditions; apparently needless rules, with equally unaccountable exceptions thereto; human peculiarities, not only as to the skeleton, but as to the brain, heart and other organs; human resemblances to mammals in general; features which unite man with the tailless apes, and separate them all from the other mammals; transitory human organs and conditions which resemble the permanent organs and conditions of other mammals, especially apes; human anomalies resembling the normal structures of apes; anomalies and malformations affecting

man and other vertebrates in a similar manner; evidences of accident and disease among wild animals.

Presumed lines of human descent may be indicated better than by diagrams upon a plane surface, by placing actual representatives of the various groups, not upon fixed shelves, but upon brackets capable of adjustment.

The candid teacher or curator will endeavor to show not only the facts which seem to support evolution, but also those which constitute its difficulties.

A statue of Darwin has recently been unveiled in London with honorable ceremonies. What monument to his memory could be more appropriate or lasting than the formation, in all educational institutions, of collections especially designed to exhibit the facts which he made significant, and the ideas which his knowledge, his industry, and his honesty have caused to underlie the intelligent study of nature throughout the world?

PROCEEDINGS OF THE SECTION OF BIOLOGY.

THE biological section opened with two papers by Prof. E. L. Sturtevant as the result of observations and experiments at the New-York agricultural experiment station. The first, on the hybridization and cross-fertilization of plants, showed in a conclusive manner that in our common vegetables (peas, corn, beans, barley, lettuce, are some of the forms experimented with), cross-fertilization tends toward atavism rather than to a blending of individual properties of the parent plants. As a rule, all the crosses tended to revert to an ancestral form, regaining in many cases characters which the immediate parent had lost. The paper forms a valuable contribution to the subject of the origin of species, on account of the carefulness of experiment and accuracy of observation apparent in the work. In the second, 'Germination studies,' the author states, as a result of many trials with commercial seeds of our common plants, that very extended series of trials must be made with each species in order to obtain the desired accuracy in results; since in a short series of trials many errors will probably occur which would be eliminated from the final result by the use of a larger series. Prof. W. J. Beal of the Michigan agricultural college described an experiment on the longevity and endurance of seeds — in which ripe seeds were buried in sand below frost for five years, at the end of which time they were exposed to frost for a period of two years and a half more.

An interesting paper on the biological deductions to be drawn from a comparative study of the influence of cocaine and atropine on the organs of circulation, was given by Dr. H. G. Berger, U.S.N. The generally accepted opinions regarding the use of atropine, muscarine and cocaine, on the organs of circulation, are, that atropine induces an augmentation and acceleration of the circulation by paralyzing the vagus nerve-endings in the substance of the heart; and that muscarine, by acting as a stimulus to the same nerve-endings, produces diastolic arrest. The later view of Glousc, however, is, that the arrest is due to its paralyzing influence on the muscles of the heart. The main points in these two views are, 1°, that the action is purely a nervous phenomenon; 2°, that it is purely muscular. When atropized blood is put into a frog's heart, the organ is first highly stimulated, but shows evidence of exhaustion by over-stimulation; this is associated with a break in the rhythm of the beats, the auricles contracting two to three times oftener per minute than the ventricles: the dose of atropine can be so regulated that this unrhythmical action may be kept up indefinitely, and even be reproduced in a heart which has recovered from atropization in normal blood. The most rational explanation of this phenomenon is found in the facts, that, while muscarine paralyzes, atropine stimulates, the cardiac muscles as well as the cardiac nerve-endings; though in case of the latter only in a slight degree. Cocaine affects the nerve-endings within the heart much the same as atropine, but is not a muscular stimulant. From his researches, Dr. Berger reached the conclusion that the drugs used acted directly on the muscle-tissue, producing paralysis, and not indirectly through the nerve-endings, — a view which was combated by Profs. Charles A. Sewall and H. N. Martin in the discussion which followed the reading of the paper.

'On the brain and auditory organs of a Permian theromorph saurian' was the title of an interesting paper by Prof. E. D. Cope. The author called special attention to the morphology of the brain, the character of the cranial walls and the auditory apparatus. The characters of the brain were considered to show affinities to the reptilian and the simpler mammalian types. The corpora quadrigemini are small, and the cerebral hemispheres exceedingly small — relatively inferior in bulk to those of any other known animal. The epiphysis is larger than is usual for reptiles. The absence of an optic foramen is a very striking character. This form is peculiarly characterized by the presence of a large oval foramen in the frontal region, the exact nature of which has not been determined. The vestibule and its walls were thoroughly described, and the relations of the well-formed semicircular canals explained. The stapedial bone connects with the fenestra ovalis external to the brain case, and at a great distance from the cochlea — the cavity of which is a mere extension of the fenestra ovalis to the vestibule. The semicircular canals resemble those of modern reptiles.

Mr. A. W. Butler presented many interesting facts concerning the habits of the musk-rat. The author mentioned well-authenticated cases of the change of habits as a means of adapting itself to the changed conditions of life, — conditions brought about by the presence of civilized man.

The disputed question of the bisexuality of the pond-scums (Zygnemaceae) was discussed by Prof. C. E. Bessey of the University of Nebraska, who concluded that these organisms do not possess true bisexuality such as Bennett of England claims for

them. All the observed facts of the conjugation of these algae tend to prove that sexuality is in its beginning, but as yet there is no differentiation into male and female elements; so that we cannot speak of a bisexuality, although there is a union of two distinct bodies of protoplasm. One fact not observed by Bennett is that of the formation of a resting spore by union of the protoplasm of two adjacent cells of the same filament. The position of the Zygnemaceae is among the lower Thallophytes, but little above the Protophytes.

'On the process of cross-fertilization in Campanula americana' was the title of a paper presented by Prof. C. R. Barnes. In this strongly proterandrous species, the pollen is scraped out of the anthers, by the hairy style, at a period anterior to the maturation of the stigmas; before the occurrence of which, the pollen has disappeared from the style. In this manner cross-fertilization is rendered certain. The pollen develops normally. The stigmas are held together until mature by interlocking papillae. The hairs on the style become introverted, and thus free the pollen. The pollen-spore contains two nuclei, the larger of which (the vegetative) becomes disorganized shortly after entering the pollen-tube, the smaller (the spindle-shaped), generative nucleus persists. The embryo sac is cylindrical with a gradual enlargement near the upper end, where is located the egg apparatus, and an abrupt enlargement at the base in which lie the antipodal cells. The pollen-tubes enter the style between the bases of the papillae of the stigma, pass down in the strands of the conducting tissue, and not through the central canal around which the tissue is arranged.

Dr. C. V. Riley presented a paper on the song-notes of the periodical cicada, and the mechanism by which they are produced. The author gave the first accurate description of the three characteristic notes of the insect, noting the variations for the individual and for thermal and hygrometric conditions of the atmosphere. The same author, in another paper, corrected the erroneous notions, that var. Cassinii Fish represents the race tredecim Riley, and that the twigs containing the eggs necessarily break off before the hatching of the larvae.

In a paper on the proof that bacteria are the direct cause of the disease known as pear blight, Mr. J. C. Arthur demonstrated by the results of his carefully conducted experiments that, 1°. Sap from an infested tree when inoculated into a healthy tree invariably produced the disease called blight. 2°. When cultures to the sixth generation of organisms were made with all precaution to prevent error, and healthy trees were inoculated with the pure culture of this sixth generation, the tree is stricken with blight, starting from the point of inoculation, and gradually extending over the whole plant. 3°. That wherever there is a blight not produced by freezing, bacteria of this species are invariably present. In order to complete the value of this work, there yet remains to discover some certain method of prevention or cure.

A paper on aquatic respiration in soft-shelled turtles (Aspidonectes and Amyda) was presented by Profs. Simon H. and S. S. Phelps Gage as a contribution to the physiology of respiration in vertebrates. One of the characteristics by which reptiles are said to be distinguished from amphibians is, that their respiration is exclusively aerial at all periods of their life. This assertion is made by all authors, except Agassiz, who adds a slight qualification. On the strength of the experiments and observations of the authors, this general character must be given up, since they have demonstrated beyond a doubt that at least in the soft-shelled turtles respiration is normally and constantly carried on by means of a respiratory apparatus, whose essential features, physiologically considered, are those of a gill. There is here, as in the adult Dipnoi, and some ganoids, a double respiration, aerial and aquatic. The facts which go to prove that we have in this case to deal with aquatic respiration are, 1°. Rhythmical movements of the hyoid apparatus, by means of which water is forced in and out of the pharyngeal cavity, thus insuring a constant flow of water over the pharyngeal mucosa. 2°. The habit these turtles have of remaining under water from two to ten hours voluntarily, and their ability to endure a submersion of fifteen hours in running water without apparent inconvenience. 3°. The structure of the lining membrane of the pharynx with the copious blood-supply. The surface of the mucosa is prolonged into simple and compound papillae of various shapes and sizes, many of them recalling the gill tufts of Necturus. The fourth and absolute proof of the aquatic respiration consists in the results of chemical analyses made by Professors Rich and Holton of Cornell university, who carefully tested the water in which a turtle had been immersed without access to air, and found a marked decrease in the amount of free oxygen in the water, and an increase in the quantity of carbon dioxide held in solution.

The following table shows the result of the analyses. In the first column is given the amount of oxygen in the quantity of water used in the experiment (1 kg). The second column contains the quantity of CO_2 which could be made from this O. The third column contains the actual amount of the CO_2 found in the water, the excess of which over the amount to be from the oxygen in water itself is given in the fourth column.

	O.	CO_2.	Actual CO_2.	Excess Co_2.
July 11,	71 mg.	$97\frac{5}{8}$ mg.	231 mg.	$133\frac{3}{8}$ mg.
Aug. 8,	32 "	44 "	$212\frac{7}{10}$ "	168.7 "
Aug. 9,	39 "	$55\frac{5}{8}$ "	168.7 "	$118\frac{3}{40}$ "

The excess of CO_2 in the water is accounted for by the presence of a certain quantity of O in the lungs of the animal at the moment of submersion, and by the intramolecular O of the tissues of the animal's body. An analysis of the contents of the lung revealed the total absence of O, and of CO_2 was found only a trace. The O is taken from the water by the papillate pharyngeal mucosa, the details of the structure of which lack of space forbids giving here.

Prof. C. E. Bessey read a paper on the inflorescence of Cuscuta glomerata. In his studies of this degraded morning-glory, the author has discovered that the dodder produces its flowers upon short, adventitious

branches, which themselves repeatedly branch, and are closely covered with scales. A further examination shows that this is the universal rule with the species, no normal inflorescence developing. The adventitious inflorescence always bears a definite relation to the position of the parasitic roots: that portion of the stem which produces roots, always produces flowers; and the greater the number of the former, the larger is the number of the latter. The stem proper dies away soon, not only between the inflorescence, but also in the flower-clusters themselves. The flowering branches establish direct structural connection with the host plant. When this is accomplished, the scales upon the branches often contain considerable quantities of chlorophyl.

A short paper by Prof. B. G. Wilder was read on the subject of the serrated appendages of Amia. The view held by Sagemehl and Ramsey Wright, that these organs are accessory respiratory organs, is found to be sustained by the experiment which Professor Wilder performed on the living animal; and his conclusions are, that, while the appendages have no function at the present day, it is quite probable that their development and paleontological history are well worth careful study.

Dr. C. S. Minot discussed the subject of the relation between histological differentiation and death, and arrived at the conclusion, that the only rational explanation of the fact that animals and plants undergo progressive decay, as well as a progressive development, is to be found in the fact that highly differentiated structures, or organs, have lost the plasticity of embryonic tissues, and are incapable of renewing themselves when once worn out: in consequence of this, death is the price paid by the higher organisms for their advanced organization.

In another paper, on the morphology of the supra renal capsules, Dr. Minot made an important addition to our knowledge of the structure of these still problematical organs. The structure of the capsule is similar throughout. There are masses and cords of cells which are in radial lines externally, but which are irregularly arranged internally. The cells of the medulla and cortex are almost identical in appearance in a six months' human foetus, on which account it is difficult to admit a double origin for the capsules. The same speaker presented a paper on a new membrane of the human skin, which he homologizes with the epitrichium of the lauropsida. It is situated outside the horny layer, and is entirely distinct from it: an extension covers both hairs and glands. It probably causes the vernix caseosa by retaining the sebaceous secretion.

An interesting and important paper on the embryology of Onoclea and other ferns was contributed by Mr. D. H. Campbell of Detroit, the details of which cannot be given here. Drs. D. E. Salmon and T. Smith of Washington, D.C., read a paper on a new chromogenous bacillus (Bacillus luteus suis). This form is non-pathogenic, and was found in the pericardial and peritoneal fluids in swine killed for the purpose of studying the swine fever. When grown in a meat infusion, the liquid becomes pale straw color, then orange with a greenish tint, soon changing to a wine red. The pigment when obtained pure is insoluble in alcohol or ether. An aqueous solution is decolorized by adding an excess of strong HNO_3, or HCl, but reappears on neutralizing with potassium hydrate, or ammonia.

The relation of ovary and perianth in the development of dicotyledons was discussed by Prof. J. M. Coulter. A most simple and important character of systematic value was discovered in the study of the embryology of the dandelion; and, on comparing with the same embryonic stages of a large number of families, it was found that the character of superior or inferior ovary was the first recognized. In the case of an inferior ovary, the protuberance, which is to develop into the flower, is arrested in its axial development, grows perpendicularly into a collar (the nascent floral envelopes), and soon there appears an external constriction distinguishing the floral envelopes above from the ovary below. In the case of a superior ovary, the axial development is continued, and there is no external constriction. On such a basis the Compositae stand at the head of the list, then Umbelliferae, Rubiaceae, etc. The second group, that of a superior ovary, includes Leguminosae, Scrophulariaceae, Labiatae, etc. A paper on the structure and functions of the sphaeridia of the Echinoidea was read by Dr. Howard Ayers. The observations of Lovén were supplemented by a large number of structural facts, which, besides allowing of greater accuracy in determining the function of these peculiar organs, furnish an example of a highly specialized organ in this group that is comparable to the otolith sacs of Synapta. The following papers were read, of which extracts cannot be given here: 'The importance of individual facts of environment in the formation of groups of animals,' by Prof. J. B. Steere; 'On the morphology of the carapax and sternum of the decapod Crustacea,' by Dr. H. Ayers; 'Notes on some injurious fungi of California,' by Prof. W. G. Farlow; 'On the evolution of the lungs,' by Dr. C. S. Minot.

THE LIMITATIONS AND VALUE OF HISTOLOGICAL INVESTIGATION.[1]

WHILE choosing a subject relating chiefly to microscopic structure for the address before the section of histology and microscopy, I wish first to discuss briefly what constitutes a complete knowledge of structure, and what are the limitations and value of this knowledge. The knowledge of structure depends greatly upon the coarser, i.e., the macroscopic relations. There is no magic in the microscope; it is simply a tool, nothing more. It is as illogical and hopeless to expect to understand the structure of an organ from what can be learned of it under the microscope alone, as for a geologist to expect to understand the topography of a continent by studying the sand of its sea-shore.

[1] Abstract of an address delivered before the section of microscopy and histology of the American association for the advancement of science, at Ann Arbor, Aug. 26, by Prof. S. H. GAGE of Cornell University, vice-president of the section.

Microscopic anatomy should show: 1°. The nature and relations of the structural elements which combine to form any organ or tissue. 2°. The blood-supply. 3°. The lymph-supply. 4°. The nerve-supply, and relation of the nerves to the structural elements. 5°. The development of the structural elements, and their combination to form the various tissues. The structure of no tissue or part is known in all this detail. This is both encouraging and discouraging; for, while we see many problems unsolved, we know that they are problems which have eluded the grasp of the greatest anatomists of the world.

It is often said that a certain tissue must perform a given function on account of its structure; but we know that a moner or an amoeba performs all the life functions observed in the higher animals, and hence it seems hopeless to tell by structure alone what the function of individual cells composing one of the higher animals must be. Claude Bernard has said that structure is the key to the grosser and merely mechanical functions alone; and this is fully justified by the facts, that, before his work, the liver was thought to simply produce bile, and the pancreas to secrete saliva; yet the physiologist Bernard found the liver a manufactory of sugar, and the pancreas producing a juice with the powers of all the digestive ferments combined with the power of emulsifying fat. While, therefore, the most intimate structural knowledge gives no hint of the function of a tissue, it is of great value when the function is known in determining the significance of the structural relations.

Knowing the special differentiations accompanying a function, it is usually safe to assume that a similar structure will possess similar properties, and perform nearly the same function, no matter where found. Structural knowledge is also of great value to the morphologist, helping him to recognize and homologize the organs of different animals. Finally, without the knowledge of structure added to the knowledge of physiology, the splendid achievements of modern surgery would be impossible. While our structural knowledge is already great and valuable, our insight into the relations of structure to function is still very slight.

While specialization of function and differentiation of structure are concomitant, no one as yet can state the finer structural relations which accompany extreme specialization of function. It is not difficult to detect a nerve-fibre; but, from appearance, no one can yet say whether its function is associated with motion, sensation, or secretion: between these functions the gulf remains impassable.

Let me now call attention to the structure of an organ in the pharynx of the soft-shelled turtles, and briefly state my reasons for claiming that the mucous membrane of the pharynx is a *respiratory* organ. These turtles remain voluntarily from two to ten hours under water; and, while under, fill the pharynx with water, and expel it about sixteen times per minute: water so used has lost part of its free oxygen, and gained much carbon dioxide.

The pharyngeal mucosa is densely covered with minute cylindrical compound, or filamentous papillae, having the appearance of the villous coat of the intestinal mucosa. This membrane begins opposite the tongue's base, and extends to about opposite the third cervical vertebra, where it passes into the oesophageal mucosa, the beginning of which is surrounded by a sphincter, thus marking off the respiratory chamber. The epithelium of the mouth, pharynx and oesophagus consists of nonciliated nucleated cells, is many layered and stratified in the mouth, but gradually becomes columnar in the pharynx. The columnar cells are interspersed with small cells wedged into the spaces between their inner ends. Both kinds of cells send processes from their inner ends to help form the strong basement membrane. Sometimes the small cells are connected with the stellate cells of the deeper tissue by long processes. Beaker cells are found in the pharynx and oesophagus, but not in the strictly respiratory part. The blood-supply is copious, consisting of a capillary net work. A plexus of non-nucleated nerves gives off branches to the papillae, and probably terminate in the taste-buds (neuro-epithelia) found there.

Such is in brief the structure of this membrane. What is the special significance of this structure? Does it agree with other respiratory membranes? In the gill of a fish the blood-supply is abundant, as here; but the epithelium is tessellated, not columnar. In the external gills of the tadpole and newt, the structure is much the same, except that a columnar ciliated epithelium intervenes between blood-supply and the water. In the inner gill of the tadpole and external of Necturus a pavement epithelium is present. If compared with the lung membranes of air-breathers, there is a general agreement of structural facts; but the structure of each of these membranes stands out clearly from all the rest, that of the turtle resembling none so much as it does the villous membrane of the small intestine of a mammal. Yet the principal function of each of these membranes is the passing into the blood of oxygen, and the passing out from the blood of carbon dioxide. That these membranes vary widely as regards structure, while possessing identical functions, is but one more demonstration of the fact that, if we would have the whole truth, the study of structure and function must go hand in hand.

PROCEEDINGS OF THE SECTION OF HISTOLOGY AND MICROSCOPY.

WE have to record the cessation of section G, histology and microscopy, of the American association. This anomalous section, finding its end near, proceeded with dignity to request the association to kill it: the request has been granted, and we are consequently forced to write an obituary of an existence which we have long disapproved. Not that we are in any way opposed to microscopy, the most delightful of what-not sciences, but because microscopy had to be dignified by rob-

bing biology of its histology. To this the histologists have strenuously objected: the extreme of feeling was, perhaps, reached by one of these gentlemen, who declined the nomination to the presidency of the section on the ground that the establishment of the section was a disgrace to the association! However this may be exaggerated, it indicates the general sentiment among histologists, that their investigations are morphological or biological, and not 'microscopical.'

We have pointed out on previous occasions that microscopy does not constitute a natural division of science, but is a compound of fragments taken from many distinct sciences, and patched together by the arbitrary association with a single instrument. In the American association, the sections are distinguished according to natural lines of division in the domain of science, all except that of microscropy, which existed by encroachment on every one of its neighbors. Its trespasses will, we trust, now find posthumous forgiveness. On the other hand, there are many technical processes which are of interest to the majority of those who habitually use the microscope, but not to others; and these processes are essential to many investigations: it is to be hoped that Dr. Minot's suggestion, of forming a microscopical club within the association, will be carried out to insure the cultivation of technique among the members interested. In conclusion, we may mention another cause of the failure of section G; namely, the prosperity of the American society of microscopists, which has withdrawn many from the association who might otherwise have made the section successful. We fear that some of the microscopists may feel themselves to have been slighted; but surely such has not been the intention, for it must not be forgotten that the change was made at the request of the section itself.

The address of the president of the section was admirable. It was well received, and in itself the most valuable communication presented to the section. For the rest, the attendance was very small, and there were only four papers presented. In fact, the section exhibited too plainly its moribund condition.

Mr. W. H. Walmsley read a paper which will be of much value to photo-micrographers, as it gives exact directions for lantern-slides with gelatine plates. Mr. Walmsley described the methods which his own extended experience has led him to prefer, and added accounts of several manipulations and ingenious devices of his own. The utility of the paper is mainly practical. We have understood that it will appear in full in the proceedings.

Prof. T. J. Burrill reports that Dr. H. J. Detmers has obtained good photographs of Amphipleura pellucida by the use of a common coal-oil lamp. Still better results than with balsam preparations may be obtained with imbedding media of higher index. He says, further, "At my suggestion, Mr. S. W. Stratton designed and constructed a new heliostat of simple mechanism, which answers the purpose required in photo-micrography as well as the more elaborate and more expensive instruments, and which is far more readily managed. For those who need to have the sun's rays constantly thrown in any given direction for one day only without resetting, the apparatus is all that may be desired."

Mr. C. P. Hart described a clever manner of making a microscope into a microtome by using the tube to carry the imbedded object, and the movable stage to carry the razor: the object to be cut is moved by the fine adjustment.

THE NATIVE TRIBES OF ALASKA.[1]

THE first half of Capt. Dall's address was devoted to the history of investigations into the anthropology of Alaska, which he divided into three periods. The first began with the expedition of Bering and Chirikoff, and continued during the remainder of the eighteenth century. The second began with the establishment of the Russian American company, and the third with the expedition of Mr. Robert Kennicott. The remainder of the address was taken up with an account of the native tribes of the region concerned, and closed with an attempt to classify the various tribes of the far north-west. We give almost without abbreviation that portion of the body of the address which deals with the Innuit.

Most of the Arctic Innuit are not separated into tribes in the same sense that the Indians of the United States, east of the Mississippi, were at the time of their discovery, nor even to the same extent as those Innuit south from Kotzebue Sound on the north-west coast. Terms are used to indicate the groups of Innuit geographically separated from each other by a stretch of unoccupied coast; and, for convenience, these terms are referred to as tribes. This is practically their own fashion. The people are all known as Innuit: those from a certain quarter have a special name, and those from each village in that district, or each river, have a still more special name. But there are no chiefs, no tribal relations in the strict sense; and the only distinction used among the people referred to is based on their locality of origin: they freely migrate from village to village, or district, and are not regarded as foreigners, though the obligation of free hospitality is not felt to be binding in regard to strangers from a distance long domiciled in another than their native village. We have no new information from the Kopagmut, nor from the people of the Colville River, except a few notes derived from the Point Barrow people by Prof.

[1] Abstract of an address delivered before the section of anthropology of the American association for the advancement of science, at Ann Arbor, Sept. 1, by Mr. W. H. DALL of Washington, vice-president of the section.

John Murdoch during his sojourn at Cape Smythe, as a member of Lieut. Ray's party on duty at the International polar station known as Ugläāini. In the course of his admirable ethnological investigations he found that the Point Barrow people have the habit of using the plural rather than the collective form of the designation for a particular people, and call those of the Mackenzie River district by the term Kŭpūng′-mi-ūn (Kopagmūt), and those of the Colville Kŭng-mŭd′-ling (Kŭng-māligmūt).

For the people of Point Barrow, Mr. Murdoch and the other members of Lieut. Ray's party obtained rich ethnological data, which are in course of publication. Some interesting facts have also been gathered by Capt. Hooper of the U. S. revenue cutter Corwin during several visits to Point Barrow. As a whole, we shall soon be in possession of very full information in regard to this isolated band.

Of the Nūnātăkmūt we have nothing since 1877; and of the Kū-ăgmūt only a few facts collected by Lieut. J. C. Cautwell of the U. S. revenue marine, during his exploration of the river in 1884. He reports that the local name of the river is Kū-ăk, not Kowak, as generally adopted on the charts. From Lieut. Stoney who followed him, and who has since returned to the region to carry on a more extensive exploration, a large addition to our knowledge of these Innuit may be expected in the near future.

Of the Innuit from Kotzebue Sound around to Norton Sound, little bearing on their classification or language has been gathered since 1877. The observations of Nordenskiöld and the Vega party at Port Clarence in 1879, and of the speaker in charge of the U. S. coast-survey party in 1880, at Port Clarence and the Diomedes, as well as Kotzebue Sound and the Asiatic coast near by; of Hooper in the Corwin, 1878–80; of the Jeannette expedition in 1879, — have added numerous facts, but little bearing on their distribution or classification which was not already known.

The most interesting people of the region adjacent to Bering Strait are the Asiatic dwellers on the coast, part of whom belong to the Korăk race, and part to the Orarian group of people. In no other ethnic group of the region has research been better rewarded since 1877. We have the admirable observations of the Vega party, the arduous explorations of Arthur and Aurel Krause, and some observations of my own, all of which, taken together, have done much to clear up one of the most knotty ethnological puzzles of the northern regions. I give the results in brief, as my time is not sufficient to go into details. The Asiatic coast presents us with the Tsaū-yū (plural Tsau-yūat) or Tsau-chū, a people of Korak extraction, commonly known as sedentary Chukchi, who have lost their reindeer and settled upon the coast, adopting from their Innuit neighbors much of their peculiar culture, but not their language. These people bear about the same relation to the wandering or reindeer Chukchi that the fishing or farming Lapps do to the mountain Lapps of Lapland. Among them, with their little villages sometimes side by side, are to be found the Asiatic Innuit, who call themselves Yūit (by local corruption of the race name), and who present essentially the features of the western Innuit of America, with some local differences. They migrate with the seasons from Cape Olintorsk to East Cape; their most northern permanent village, as far as known, is at the latter point. The Tsau-chū extend along the northern coast of Siberia much farther north and west. The two races are friendly; there is some intermingling of blood by marriage; and a jargon containing words of both dialects is used in communications between them. In my opinion, however, it is very necessary to keep in view that the culture of Tsau-chū, so far as it differs from that of the wandering Chukchi, is distinctly a derivative from that older culture of the Innuit race, though the arctic people of both hemispheres and all races have much in common, due to their environment. The word Chukchi has been so misused that it is almost meaningless; but, in the strict and accurate meaning of the word, there are no Chukchi on the American coast, as has been asserted. That error arose from the confusion between the Innuit and Yūit on the one hand, and the Tsau-chū on the other.

Of the Innuit people on the American coast at Norton Sound and southward to the peninsula of Alaska, not much additional information has been made public since 1877 bearing on their classification. That in the report on Alaska, comprised in the publications of the U. S. census of 1880, is retrograde in many particulars rather than an advance, being the work of a person unqualified for the task. Magnificent collections bearing on the culture of these people have been made by Turner, E. W. Nelson, W. J. Fisher, C. H. Mackay, and others, and have been received by the U. S. national museum. But the unfortunate ill health of Mr. Nelson and other circumstances have delayed the publication of his rich and valuable observations. A good deal has also been done in the way of collections on the island of St. Lawrence by Hooper and Nelson, and in the Aleutian Islands by Turner, Dall, and others.

With regard to the tribal limits of the western Innuit, geographically considered, they are very mutable, and, especially in recent years, are constantly changing in small details. This arises from the fact, that the geographical group, which we have called a tribe among the Innuit, and for which in some cases they have a special designation, is not a political organization headed by a chief or chiefs, but simply a geographical aggregation of people who have by possession obtained certain *de facto* rights of hunting, fishing, etc., over a certain area. The jealousy of adjacent groups keeps the imaginary boundary-line pretty well defined through fear of reprisals should it be violated. When the whites came in with trade, and established posts all over the region, they also used their power to put down any conflicts, which are always injurious to trade. The boundaries, now violable with impunity, fall into oblivion, and the more energetic hunters and trappers go where they choose. In this manner the geographical group names I have described are ceasing to have any serious significance, and every new ethnographical visitor will find himself unable to make the ancient boundaries

correspond to the distribution of the moment. Nevertheless, in a general way, the old maps, such as that of 1877, still indicate the focus of the former group or tribe, and doubtless will long continue to do so. The Innuit tribes on the Kuskokwin have been found by Nelson to extend farther up the river than was supposed in 1877, reaching nearly or quite to Kolmakoff's trading-post. The advance up the Yukon, shown on the census map, is recent, if authentic. The St. Lawrence Island people are more nearly related to the Innuit of the American coast than to those of Asia, though their commerce is with the latter and with their Korak neighbors. As regards the Innuit of the region between the Koyukuk River and the Selawik River, the miscegenation indicated by the census map has no foundation in fact. The error doubtless arose from the permission accorded by the Innuit to special parties of Tinneh to come into and through the territory of the former for purposes of trade. The north shore of the peninsula east of Port Möller is represented by the census map as occupied by the Aleuts or Unŭngŭn. The region is really not inhabited, except for a few temporary hunting-stations, except by typical Innuit. Notwithstanding these and many other errors in this compilation, it is probably correct in extending the area of Tinneh about Selawik Lake, which is a useful addition to our knowledge. In 1880, while visiting Cook's Inlet, I was enabled to determine the essential identity of the native Innuit of Kenai with those of Prince William Sound, though among them were many Konia′gmūt, brought there for purposes of trade in hunting the sea-otter.

With regard to the Aleuts, the degree of civilization to which they have attained is very promising. The people are not scattered over the archipelago except in their hunting-parties. In the western Aleutian Islands the only permanent villages are at Attu and Atka Islands. The division into groups is rather a matter of tradition than of actuality: practically they are as much one people as those of two adjacent English counties.

The easternmost of the Innuit people are the Chūgăchîgmūt of Prince William Sound. At their eastern limit, there has long been a confusion, which I supposed I had cleared up in 1874, but which has only been finally regulated by information received from the brothers Krause, and obtained by myself in 1880. The census agent who visited them in 1881 was frightened by some boisterous demonstrations, and departed in the night in a small canoe, abandoning his equipage after a stay of some forty-eight hours. Consequently very little information was obtained by him, and that of an uncertain character.

Three stocks approximate to each other at this point, — the Chūgăchîgmūt Innuit, the Tinneh of Copper River, and the Chilkaht tribe of Tlinkit. The latter have a precarious traffic coastwise, a few canoes annually reaching the Chilkaht village (sometimes called Chilkhaak) at Controller Bay by the dangerous voyage from Yakutat. But another path lies open to them, at least at times. One of Dr. Krause's Indian guides informed him that he had descended the Altsekh River (a branch of the Atna, or Copper River), which heads near the Chilkat River at the head of Lynn Canal, to a village of his own tribe at its mouth on the seacoast. Of the visits of the Ah-tenā tribe of the Tinneh I have had personal observation; and that the Chūgăchîgmūt pass by them to the Kayak Island in summer, all authorities are agreed. This information explains the confusion of previous evidence, and shows why the vocabularies have sometimes afforded testimony in favor of one view, and sometimes of another. A jargon is probably in use in communications between the Tlinkit and the Innuit. That any ethnic intermingling of blood has taken place, I regard as too improbable to be worth consideration, having had personal evidence of the fear and hate existing between the two peoples. There is some distrust between the Tinneh and the Innuit, as elsewhere; but the bold and aggressive Tlinkit have committed so many outrages upon the timid and peaceable Chūgăchîgmūt, that the feeling there is of a much more bitter character.

I have elsewhere stated my reasons for believing that the Innuit formerly extended much farther to the south and east. Nothing has since been discovered which materially affects the grounds of this belief of mine, and the subject is an interesting one for future investigation.

PROCEEDINGS OF THE SECTION OF ANTHROPOLOGY.

THE meetings of this section were held with great regularity. The papers were all read on the days indicated, and were most of them of great interest and value, the hall assigned to the meetings being always filled with an interested audience.

The first paper, by Rev. Mr. Dorsey, gave an account of a visit to the Siletz agency. The author had spent several months at this agency, engaged chiefly in linguistic studies. The agency is located near the coast of Oregon, not far from the Columbia River. The Indians at the agency are all of them more or less civilized, and some of them take newspapers. In complexion they are lighter than most Indians, and are very short. The adult women, especially the older ones, have the face disfigured by tattooed lines. In many respects, both men and women resemble the Ainos. In their treatment of strangers, the Siletz Indians are very polite. The population of the agency is made up by the consolidation of over twenty tribes, none of whom are the original Siletz. Because of this, the language spoken is a jargon. The greater part of the paper consisted of a very methodical and scholarly account of the peculiarities of this language. A few only of the characteristics mentioned can be given. The verb varies with the position of the object. They cannot say 'that man,' but must say 'that man walking,' or sitting, or standing, etc. There are three sets of cardinal numbers, human, inhuman, and inanimate. Possessive endings are found in many words. All

their villages, of which two hundred and seventy have been located, have local names; as, 'the people of the ash-trees,' 'the people by the hill, 'the people of the cañon,' etc. A man must marry a woman from another village, and his children belong to the village of their father. They will not mention the names of the wild-cat, field-mouse, and some other animals before their children, lest they bring sickness and death upon them. Five is the mystic number among them. The paper closed with the Siletz myth of the creation. Following the paper were remarks by several members of the section. Attention was called to two popular errors concerning the Indians: one, that among them women are degraded, and mere slaves. Miss Fletcher and others showed very emphatically that women have great influence in the tribe; and, when married, they lose nothing of their identity, not even their names. Another error is, that the Indian is stolid, unemotional, and even sullen; whereas, in truth, he is impulsive, fond of a joke, and keen to appreciate it; sympathetic, and grateful for any kindness shown him. One speaker mentioned some of the customs of the Pawnees, who were divided into four clans or groups; and these were so distinct from each other, that formerly the members of different clans scarcely knew each other, and they married only within their own group.

Next came a paper by Rev. W. M. Beauchamp, on the permanence of early Iroquois clans and sachemships. The speaker showed that many of the institutions of the tribes forming the Iroquois league were far from being so unchangeable as had been supposed. He believed that historical evidence showed that the famous league was itself formed gradually, and not very long before the advent of the whites; and he showed, that, in the time of Champlain and other early explorers, it was only a loose confederation. The use of wampum is not of very remote antiquity, and had been known for no long time when the country was discovered. Changes had occurred both in the number of sachems and in the mode of electing them. Although the general rule, that the chieftainship was not hereditary in the line of the father, was usually followed, there were exceptions, — the son succeeding his father in office, and, in at least one case, his son following him.

Mr. A. W. Butler then read a paper on the remains at San Juan Teotihuacan. These ruins are about twenty-seven miles from the city of Mexico, near a small station on the new railway. After proceeding a short distance from the station, the ground is covered with obsidian flakes, spear-points, knives, bits of pottery, heads and figures of pottery; while here and there appear ruins of houses, with the walls decorated in figures of bright red and yellow. The chief ruins appear first as huge masses covered with bushes and other vegetation. Only upon close examination does the pyramidal form appear. The first and largest pyramid is called 'the house of the sun.' Its base is 682 feet long and a little less in width, while its height is 221 feet. About the base are numerous small mounds; and on the eastern side is a path, which, in zigzag-fashion, passes to the top. In this path are what appear to be steps made of volcanic rock fixed in cement. From the top a great number of ruins may be seen in every direction. On the top are several larger stones than any about the pyramid; and it may be that these are what is left of the temple of the sun, which, according to early writers, stood there. North-west from this pyramid, and distant about a thousand yards, is a smaller pyramid, 'the house of the moon.' The rectangular base of this is 511 feet long and 426 wide, and the height is 137 feet. Both pyramids are truncated at the summit, and built in three terraces, each terrace receding six feet from that below. Each of the three terraces was built by itself, and made of earth covered with a coating of cement, varying in thickness from three to six inches; and finally, when the full height was reached, another coating of cement was spread over the whole. Imbedded in this outer layer are numerous fragments of volcanic rock. The author described the profusion of objects of obsidian and earthenware which were strewn over the ground about the pyramids, and urged a speedy and diligent study of the region by competent archeologists. In the discussion following the paper, the pyramids named were compared with that of Cholula, and some of the points of difference were mentioned. The pyramid of Cholula is a mass of earth like those described in the paper; but, while these are covered with cement, that is built up on the outside with adobe brick.

Following this paper was one on the significance of flora to the Iroquois, by Mrs. E. A. Smith. The paper was a study of the names given to various trees and plants in the different nations of the Iroquois, and a comparison of these names, thus tracing them up to the parent stock.

Prof. N. H. Winchell exhibited a sheet of what he believed to be an alloy of copper and silver, as very careful analysis and examination showed it to be. The author first showed that no such alloy was known as a natural product, and that hitherto nothing like it had been found among the remains of the aborigines. The sheet was about half an inch thick, of triangular shape, partly rolled up, and weighs eight pounds. It was found near Temperance River, Minn. In the remarks which followed this paper, Mr. F. W. Putnam said that he believed that all the copper objects found in the United States were made of beaten copper not cast. He also described certain ornaments made of silver and copper beaten together; but none of alloy were ever found in North America, although in South America silver and copper alloyed to form bronze had been found.

On Friday morning the opening paper was by Miss A. C. Fletcher, on the sacred war-tent, and some war customs of the Omahas. Like all of Miss Fletcher's papers, this was a very clear, minute, and valuable account, and was received by the section as a most welcome contribution. The sacred tent is used for the storing of the sacred objects of the tribe, such as are used in its rituals and ceremonies. These objects were held in great reverence, and most sedulously

guarded. The tent has a special keeper, whose business is to care for it and its contents. These contents consisted of the sacred shell, which is a large river shell or Unio. This shell is contained in several leather pouches, one within the other; and in the shell itself are placed strips of the inner bark of the cedar, and a scalp. In the tent are also the sacred wolf-skin, and two bundles covered with tanned skins. One of these bundles is somewhat like a duck in form, and contains sundry bird-skins; the other is box-like in shape, and no one now living knows its contents, except that it contains various deadly poisons. There are also a staff of cedar and one of iron-wood, a small pipe-stem, two war-pipes, tobacco, and a scalp, obtained by warriors who had obtained the wolf-skin. All of these objects, which for generations had been kept and cherished by the Omahas as their most precious possession, have been given over to the care of the Peabody museum of archaeology by their keeper, with the consent of the other chiefs. This action is most important; since it marks the determination of the tribe to leave forever the usages of their fathers, and to continue in those of civilization which they have already adopted. The use and significance of some of the sacred articles were described. The sacred shell must never touch the ground; as, if it did, a devouring fire would come from it, which would destroy vegetation, and even streams and springs. To prevent this, the shell in its pouches is hung up in the tent; and when the tribe is on the march, the shell is carried by a boy especially chosen for the purpose. This boy slings the pouch over his shoulder, and is provided with a pointed staff to assist him should he stumble. If the boy wishes to play, he may thrust his staff in the ground, and hang the shell upon it. No one, except the keeper, may even touch the sacred objects: if he does, grievous sores will come upon him. Although, if one has accidentally touched them, he may be allowed to go through certain ablutions, assisted by the keeper, until he is purified; and then the evil is averted. If an enemy is supposed to be prowling about, and it is thought best to send out scouts, they are prepared by certain ceremonies. The sacred pipes are filled and offered to them; and they are solemnly admonished to report on their return only the exact truth, and to be careful to observe well. It is regarded as a very great honor to be chosen to act as scout. The poisons contained in the box-like bundle are used in various ways. One use is in punishing a mischief-maker, or incorrigibly troublesome member of the tribe. A staff is poisoned, and given to a discreet young man, who goes at night to where the offender's ponies are, and pushes his stick against them one by one, breaking the skin, so that the poison may get into the blood; and before morning all the ponies poisoned will be dead. The severity of the punishment determines the number of ponies so destroyed. There are ten distinct honors which may be obtained from the killing of an enemy; and they may be indicated by eagle's feathers, or other ornament. These honors are, one may kill an enemy, four may strike him, four may take his scalp, and one may cut off his head. The degree of danger involved in an exploit affects the honor received from it; e.g., to strike an enemy is a greater honor than to shoot him from a distance. The speaker called attention to the fact, that Indians were very fond of deceiving the whites in their dress, putting on wholly incongruous things merely for effect or sport, and arraying themselves as they would never do when wearing only what they had a right to wear. On this account, many of Catlin's pictures are incorrect, and many of the costumes worn by the delegations to Washington are not such as the wearers would ever assume at home. A curious custom exists among the Omahas. When a warrior is recounting his deeds before the tribe, he holds a short stick in his hand over a small pack in which is a hole. When so ordered, the boasting one must unclose his hand, and let the stick drop; and if it rolls into the hole, he has told the truth; but if it rolls off, as it is very likely to do, he has at least made a mistake. When on the war-path, Indians are trained, as one expressed it, 'to walk as one dead;' that is, to be wholly indifferent and insensible to all bodily discomforts and dangers. The war-party consists of warriors and servants. The servants are usually young men, and it is for their interest to act as such; for, in this way, they accompany the war-party, and, if a conflict takes place, they are allowed to hide their kettles and camp-equipage, and to engage in the battle; and, if one strikes one of the enemy, he is promoted to the rank of warrior. The dress of the warrior is simple, and over all is thrown a buffalo-robe worn with the hair inside. This is tied by leather strings; and day and night it must be worn, and the strings not untied until the enemy is met, or else the war-path abandoned.

Mr. F. La Flesche read a paper on the laws and terms of relationship of the Omahas. This was a paper of especial value, in that it afforded the section an opportunity of hearing, not from one who had gathered his information from strangers, but from one who had received it from his parents, and grown up among the customs described, and who spoke of his own people. Reference was made so constantly to a diagram, that is impossible to give any abstract of the paper that would be of much value. The singularly intricate, and to us absurd, system of relationship which has long been in use among the Omahas, was very clearly explained.

The next paper was by Mr. W. McAdams, on the exploration of recent Indian mounds in Dakota. The mounds in question were small burial mounds. Some of them, in one case a chain of four, were connected by a path of buffalo bones, which not only extended to the mounds, but directly over some of them. The bones were bleached very white, but there was no evidence of great antiquity anywhere. Aside from a small stone axe, only human bones were taken from the mounds opened. At the close of the paper, Mr. F. W. Putnam spoke of the conditions in which bones might be well preserved, and other conditions in which they would soon decay; and on this account the soundness or decay of bones was of little value in determining their age, unless the surroundings were well known.

In a paper on the burial customs of our aborigines, Mr. Henry Gillman exhibited two skulls, which had been perforated on top in one case by a single hole, and in the other by two. The holes were a little less than half an inch in diameter. The author regarded them as made soon after death, and perhaps as part of the burial ceremonies. Cremation prevailed over Michigan. Food was left for the dead. Sometimes the totem of the deceased was cut on a cedar board and placed at the head of the grave. In some cases the wigwam was consumed with the body. Mr. La Flesche said, remarking upon this paper, that among some tribes, if people died far from home, the body could not be transported; but the flesh and soft parts were removed, and then the bones could be carried back to the home for burial. Mr. F. W. Putnam spoke of the discovery of perforated skulls in Ohio. In one mound, there was a circle of sixteen skulls around two skeletons; and eight of these skulls were perforated, and all showed marks of scrapers used to clean them. On some of these were as many as ten holes.

'Ancient pictographs in Illinois and Missouri' was the subject of the next paper, by Mr. W. McAdams. Diagrams of figures carved on the walls of a cave in Missouri were exhibited; and also other figures found in a locality in Illinois, where there were painted figures of animals. Another diagram represented a composite monster, which was painted on a cliff near Alton, and remained intact until a few years ago.

Mr. W. L. Coffinberry exhibited some very fine specimens of stone, bone, and pottery collected in Michigan, after which Rev. J. W. Sanborn read a paper on the customs, language, and legends of the Senecas. He believed that the league of the Iroquois was much more ancient than some of those who had spoken before the section regarded it, and much more complex and wonderful. The Seneca language is complex: it contains no labials, nor do *r*, *q*, and *z* appear except in words introduced from the English; *h* is found either smooth or aspirate, and with very different meanings. There are five genders, three numbers, etc. The paper closed with a very remarkable myth, or legend, which one of the tribe had told the author. In the discussion which followed, evidence was given to show that the league could not have been formed so long ago as Mr. Sanborn thought; that probably there were no Iroquois in what is now New York before A.D. 1500, and probably not before 1550.

On Monday the first paper read was a long and elaborate discussion of music in speech, by Mr. M. L. Rouse. The paper was a comparative study of several prominent modern languages from the stand-point of the elocutionist and musician.

The next paper was on the stone axe in the Champlain valley, by Prof. G. H. Perkins. The author spoke of the different sorts of stone axe found in the region named; the relative abundance and elegance of the different forms; the variety found, both as to form, material, and finish; and exhibited some of the varieties mentioned. He called attention to the fact, that, while New-England stone implements have not usually been regarded as especially elegant or beautiful, yet some of the celts and other forms of the axe found near the shores of Lake Champlain are exceedingly fine; and in beauty of material, regularity of form, and smoothness of finish, some of them may be favorably compared with the best American or European specimens.

Rev. Mr. Dorsey read a very interesting account of Indian personal names, giving numerous examples, and in many cases showing how a name came to be chosen. He also gave some of the customs followed in giving names and in changing them. This change of name is not uncommon in the case of men, or even boys; but the women do not change their names.

A most delightful account of 'An average day in camp among the Sioux' was then given by Miss Fletcher. She described the taking-down of the tent preparatory to a journey, the leader's tent being first removed early in the day; then the catching the ponies for the saddle or wagon, packing the household goods, and setting out upon the march over prairies, through rivers, and on until about three in the afternoon, a suitable place being found by water and in a grove, the camp was set up again. In a most racy and vivid manner the common incidents of such a day were given, and with the zest which came from actual experience.

Several disks cut from human skulls, and worked into ornaments, were shown by Mr. F. W. Putnam. These were found in one of the Ohio mounds. They are several inches in diameter, and ornamented with incised figures. Marks of the scraper were visible upon them; showing that they were not cut from old skulls, but that they were taken from fresh subjects, and the flesh scraped from them.

A very carefully written paper upon the number-habit was read by Dr. C. S. Minot. The author referred to numerous experiments made under the auspices of the American society for psychical research, to determine, if possible, whether the so-called mind-reading had any basis in fact. In course of these experiments, numbers were used, one person thinking of a number, and another trying to guess what it was. On the doctrine of chances, the percentage of numbers rightly guessed should have been ten; but actually it was eighteen. The difference was explained by the author, by the fact that many persons formed what he called a number-habit; i.e., they were much more likely to think of some numbers than of others; and two persons having the same habit, would guess more frequently the numbers thought of than chance alone would account for. So far as the experiments of the American society went, they did not supply any reason for a belief in mind-reading; but the English society had obtained results that seemed to show that it was possible, so that judgment should for the present be reserved. Another paper by Dr. Minot was, "Are contemporary phantasms of the dead to be explained partly as folk lore?" This paper was a thoughtful and candid review of the ghost question, with the conclusion that popular beliefs and ideas, aided by imagination, were the basis of most, if not all, phantasms of the dead.

A verbal paper by Prof. G. H. Perkins, on certain strange stone implements from Vermont, consisted chiefly of general statements concerning Vermont archeology; and the exhibition of a considerable collection of peculiar implements, with remarks upon their character and rarity. The speaker mentioned the fact, that the evidences of a former occupation of the region, more extensive than has been supposed, were increasingly convincing; and also that two distinct layers, one much below the other, afforded relics.

A very excellent account of the Cahokia mound and its surroundings, with the results of his own extensive explorations, was given by Mr. W. McAdams; and many very striking resemblances to the Mexican pyramids were brought out. The writer showed by drawings and diagrams the forms and position of many mounds, which are found in the region of Cahokia in immense numbers. Mr. F. W. Putnam gave some very practical and detailed directions as to the proper exploration of mounds, pleading earnestly for thorough work in all explorations; and illustrated its value by several examples drawn from his own recent investigations. The last paper read was by Rev. Mr. Dorsey, who presented a most interesting collection of suggestive facts respecting primary classifiers in Dhegiha and cognate languages.

THE APPLICATION OF SCIENCE TO THE PRODUCTION AND CONSUMPTION OF FOOD.[1]

MR. ATKINSON, in his opening remarks, said that he presumed the business of the association was not to popularize science by lowering its standard, but to bring the progress of science and art in their application to human welfare prominently before the public. While giving full credit to those who engage in the pursuit of knowledge for its own sake, yet Mr. Atkinson would believe that their work must finally rest for its justification upon its influence on the material welfare of the race. To this end the address was devoted to the future applications of science to the production and transportation of food. In preparing the address, the speaker endeavored to bring into clear view the vast changes, both social and scientific, which have rendered the production and distribution of all commodities, especially of food, so much easier and more equitable during the present generation than ever before, and, to some extent, to show what further progress might be immediately before us. He endeavored to demonstrate, that, in the generation which will have passed between the end of our civil war to the beginning of the next century, greater progress will have been made in the way of material welfare than in any preceding period of the same length.

It is commonly assumed that the invention of the steam-engine, spinning-frame, and power-loom made greater changes in the production and distribution of wealth in a single half-century than have ever occurred before or since; but it will be observed that the forces of steam were limited during the first half of the century to reducing the cost of labor in making textile fabrics and in working mills. It is only in recent years that it has exercised any great influence on the production or distribution of food. However important clothing may be, it is relatively unimportant as compared to food in the proportion of labor required for its production.

All the available statistics prove that to the working people of this country the cost of food measured in money, including drink for whatever it is worth, is not less than three times the cost of clothing; and the proportion is even greater for the working people of Europe. How much greater this disparity must have been twenty-five years since, when the value of grain was exhausted by transportation over a hundred and fifty miles of common highway! If, then, one-half the struggle for life, measured in money, and more than one-half when measured by the work of the household of the prosperous mechanic, is the price paid for food, it is evident that the inventions and improvements of the last twenty years, which have been mainly directed to the increased production and cheap distribution of grain and meat, have affected human welfare in even greater measure than the inventions of the last century.

After referring to the advantages to the commerce of the United States, owing to the vast area over which free competition is possible, Mr. Atkinson enumerated various changes which have been brought about by the application of more scientific methods in machinery, and by the discoveries in the last twenty-five years: he referred to the displacement of the paddle-wheel by the screw-propeller; to the perfection of the compound steam-engine; to the discovery of oil-wells; and to the growing use made of electricity.

To this picture of prosperity, there is another side: vast progress has been made in individual wealth and common welfare; the time necessary to be devoted to the struggle for life has been reduced. But, great as our progress has been, and huge as our abundance now appears to be, yet the fact remains that the average product to each person in this most prosperous country, measured in money at the point of final distribution for final consumption, does not exceed fifty to fifty-five cents per capita per day; and our whole accumulated wealth, aside from land, does not exceed two, or, at the utmost, three years' production. After we have provided for the support of the government, for taxation, each average person must find shelter, and be supplied with food and clothing out of what forty to forty-five cents will buy. Moreover, whenever any great invention displaces common laborers whose development has not been of such a kind as to fit them for other work, they suffer for the time. The Yankee boy of former days, who attended the common school for three or six months in the year, and during the rest of the year was a jack-at-all-trades, was thereby enabled to

[1] Abstract of an address delivered before the section of economice science of the American association for the advancement of science, at Ann Arbor, Aug. 26, by EDWARD ATKINSON, Esq., of Boston, vice-president of the section.

become a master of any trade which he might afterwards choose. Such is not the case at present. From the census of 1880 it appears that out of every thousand persons engaged in gainful occupation, three hundred and twelve were classed as common laborers. This proportion was doubtless increased between 1880 and 1882 by immigration, and it is this class which suffered from diminished railroad-building during the last three years. The true remedy can only exist in the development of versatility and manual dexterity, and of capacity on the part of the poorest child in the community to take advantage of all opportunities which may offer.

With respect to the applications of science, crude as they are in respect to agriculture, they assure an abundance for any increased population during the present century. With respect to the mechanism of distribution, the cost has been reduced so that there is little margin for further saving. In the conversion of crude materials into forms ready for consumption, the field for improvement is still a broad one. In wholesale traffic, as well as in retail distribution, of perishable commodities, there is a waste; and in the science of consumption, almost no progress has been made.

Again recalling, however, that to common laborers their food constitutes sixty per cent of the cost of life, it will be obvious, that, if we can show them how to maintain themselves in full vigor at the cost of thirty or forty per cent of their ordinary income, we shall have done good service. Prof. W. O. Atwater of Middletown, Conn., has prepared a number of tables, in one of which it is shown, that, if we buy protein in a sirloin of beef at twenty-five cents a pound, we pay one dollar a pound for it; whereas, if we seek for protein in oatmeal or cornmeal, we pay twelve to fourteen cents for it. Mr. Atkinson praised for their cheapness the Yankee dishes of fried fishballs, and pork and beans; and also the weekly ration of the southern negro, — a peck of meal, and three and a half pounds of bacon; which, probably, supplies the cheapest subsistence known. The rice of the east may cost less in money, but is deficient in the nutrients necessary for full vigor.

While the American could live cheaply on oatmeal, or pork and beans, yet he would not willingly do so, but would wish for meat; and it is to the cheapening of the cost of meat, rather than to the reduction of its consumption, that there is need of attention. Mr. Atkinson referred to the partially abandoned lands of the New-England States, as probably capable of producing, if properly fertilized, beef at a cheaper rate than is now done by cruder methods in Texas, adding the cost of transportation to this market.

Mr. Atkinson based his scheme upon the claim of Mr. Farrish Furman of Georgia, that he is able to raise two and a half bales of cotton to the acre on abandoned cotton lands when suitably fertilized with Stassfurt potash, and the phosphate rocks of South Carolina. He would bring the cotton-seed meal to Massachusetts, there feeding it, and thus converting the minerals into fertilizing elements to be used on the barren lands of New England to raise Indian corn, which should be used as pitted fodder or ensilage for the cattle. If this proposition can be sustained, it may happen that when the population of the United States of 1880 shall have doubled, an area of land no larger than that needed in 1880 will be required to sustain the people of that day.

At the close of his address, Mr. Atkinson presented a number of statistical tables showing the cost of life of various classes of people, mostly operatives or mechanics, and some tables showing the cost of maintaining inmates of public institutions. The investigation of the statistics does not increase Mr. Atkinson's faith in the law of population propounded by Malthus, or Ricardo's theory of rent, or the so-called law of diminished returns from land.

PROCEEDINGS OF THE SECTION OF ECONOMIC SCIENCE AND STATISTICS.

THE opening paper in this section was by Mr. Henry E. Alvord of Houghton Farm, New York, upon the relative values of human foods, and had especial interest, as forming in a degree a continuation of some of the interesting considerations contained in Mr. Atkinson's vice-presidential address. The author's comparisons of different articles of human food were based upon their average chemical composition alone, it being his belief that "we are so much in the dark on the questions of the actual proportions of digestibility in different forms of food, that it is safer to drop this factor than to include it."

Selecting as his basis of comparison for animal food, average ox-beef (flesh free from bone) at sixteen cents per pound, and for vegetable food, potatoes at one cent per pound, and rating animal fat at twelve cents per pound, and the carbohydrates of vegetables at four cents per pound, he arrived at the following money values, per pound, for the three classes of nutrients: —

	Protein.	Fat.	Carbohydrates.
Animal	72 cents	12 cents	7 cents.
Vegetable	10 "	7 "	4 "

Based upon these valuations, elaborate tables were presented, showing the nutritive value expressed in money, of all important articles of human food in comparison with their cost. The investigation was undertaken with particular reference to the food value of dairy products, and the results show that skim-milk, butter-milk, and cheese, at usual retail prices, furnish a given amount of nutriment more cheaply than any other articles on the list, being approached in this respect only by fresh mackerel and dried cod-fish. Milk, on this scale, sells for about its nutritive value; while butter costs two or three times its real food value, and often more. "What shall be said," continued the speaker, "of domestic economy in America, where more butter and less cheese are consumed per capita than in any other nation in our zone? And what of the government of some of our great cities, where boards of health absolutely prohibit the sale of skimmed milk, and actually destroy all that can be found?"

Of meats, pork and mutton are the cheapest, and veal the dearest. Of fish, mackerel is cheapest. Eggs generally sell at their full food value. Wheat-flour, oat-meal, and beans are the cheapest forms of vegetable food.

In the ensuing discussion, attention was called by several speakers, including the author of the paper, to the fact that chemistry alone cannot measure the nutritive value of the food, and to the great importance of those nervous and other influences which play such an important part in nutrition. Some very interesting statements were also made by the president of the section, regarding the dietaries of the working-classes and their cost.

Next followed a paper by Dr. C. V. Riley, upon the probability of injury by locusts (grasshoppers) in the immediate future. A certain periodicity has undoubtedly been established in the visitations of these insects, a period of about eleven years, on the average, elapsing between the times of serious damage. At present, considerable apprehension exists, based upon knowledge of somewhat serious injury by locusts, in California, Montana, and Dakota. A large part of this damage has been done by local (non-migratory) species; but the migratory species are also rather numerous, and we are probably at the beginning of a period of increase. To what extent this increase may go, depends considerably upon the climatic conditions during the present summer and autumn: but it is probable, that, even in the most unfavorable case, the damage will never reach the proportions which it did in 1873–77; for the advance of civilization since that time will prevent the massing of the insects in such enormous bodies as was then possible.

This paper was followed by another, by the same author, upon a new method of destroying locusts by the use of poison-bait composed of bran, sugar, arsenic, and water, which has been used successfully in California, and promises to be valuable in some cases.

The afternoon session was opened by a paper from Mr. C. Reemelin, upon city government. After a lengthy historical review of the history of city governments, its failures and mistakes, the question of remedies was taken up. These must be chiefly sought in constitutional reform. Of special suggestions may be mentioned, the strengthening of the executive power, and its committal to one responsible head; supervision of city expenditures by state authority; a state city council of from four to ten delegates from each state, for consultation upon common interests; and reform in municipal taxation. In the discussion which followed, special stress was laid upon the fact, that in a democracy good government depends ultimately upon the individual citizen; and Mr. Reemelin's paper was criticised as leaning too much towards purely legislative remedies.

Following this, a paper was read by the president of the section, Mr. Edward Atkinson, upon insurance against loss by fire. In all systems of fire-insurance, the losses are paid from the premiums; that is, by the assured. Consequently, while at first sight it may not seem to be to the interest of the assured to take special precautions against loss by fire, it really is so; since the greater the risk of loss, the greater the premium he must pay. The speaker described the workings of an insurance company of which he is president, which aims to prevent loss by fire by a system of inspection. The system is applicable only to large manufacturing and like establishments where strict care and rigid inspection are possible. Before insuring, the owner is required to conform to certain requirements regarding construction of buildings, provision of fire-apparatus, etc. After he is insured, regular periodic inspection by the experts of the company is made, and any dangerous conditions must be remedied. In case of persistent refusal to comply with the recommendations of the company, the policy is cancelled. About the usual rate of premium is charged; and the excess of premiums over losses, amounting to a considerable proportion, is returned to the policy-holders. The interest upon the premiums paid in has nearly paid the running expenses of the company; and the saving in cost of insurance during the last thirty years, at five per cent compound interest, equals the total combustible value of the property insured.

An interesting discussion followed upon methods of construction of slow-burning buildings, automatic appliances for extinguishing fires, etc.

The morning session of Aug. 28 was opened by an exercise illustrating a method of teaching elementary science in grammar schools by Mrs. Ellen H. Richards of Boston. The method is designed to lead children to observe and think for themselves, and was very successfully illustrated with a class of children from the Ann-Arbor schools.

Following this was a paper on the present status and future prospects of silk-culture in the United States, by Dr. C. V. Riley. Silk-culture has been practised in this country for half a century; but the industry is far from being established, these trials having only shown that silk can be raised over three-fourths of the United States if there is a market for the cocoons. At present this is largely lacking, all attempts to manufacture so-called 'raw' (reeled) silk in this country having proved financial failures. The writer advocated a protective duty upon 'raw' silk to encourage the production of cocoons in the United States. The raising of silk he holds to be an industry best carried on as a domestic industry on a small scale, and as adapted especially for the many women and children who cannot readily find any other productive employment. The profits he estimates at $15 to $25 for the season for a family of three persons with cocoons at $1 per pound.

In the discussion of the paper some of Dr. Riley's conclusions were questioned by Mr. Atkinson, who maintained that the establishment of silk-culture in the United States is not desirable. There is no lack of employment for labor in the United States, as the high rate of wages shows; and the fact that the making of reeled silk has been unprofitable, shows that capital can be better employed. Silk-culture is a handicraft simply, and has always been carried on by

the poorest and most inefficient peoples, who, as they rise in the scale, abandon it, as is now coming to be the case in southern France. The argument, that we shall save the $20,000,000 which we now pay for imported silk, is fallacious. When we exchange articles produced by labor costing $1 per day, for the silk of China or Japan raised by labor costing five or ten cents per day, we gain and not lose. We cannot afford to do for ourselves what foreign paupers will do for us cheaper. A power-loom for weaving silk has probably been invented in the United States; and when this is perfected, we may buy raw silk, and manufacture it here at a profit.

The afternoon session was opened by a long and interesting paper by Gov. John W. Hoyt of Wyoming, on the need of a systematic reorganization of the executive departments of the government in the interest of science and of public economy. After describing the gradual growth of these departments, and pointing out forcibly the many incongruities and disadvantages of their present organization, and the need of a reorganization, the writer proceeded to describe his plan, which he supported with powerful arguments. It is in brief outline as follows: First, the transfer of the bureau of Indian affairs to the war department, and the separation from the interior department of various technical and scientific bureaus. Second, the separation from the treasury department of similar bureaus not properly belonging to it. Third, the expansion of the department of agriculture into a real department of industry and commerce, presided over by a cabinet officer. Fourth, the expansion of the post-office department into a department of post-offices and telegraphs. Fifth, the erection of a department of science under a cabinet officer, to include the bureau of education, the government-surveys, the signal-service, the naval observatory, the national museum, the library, a bureau of charities, the charge of government scientific expeditions, an advisory superintendence of public works, and, in short, all the scientific work of the government.

An interesting discussion followed, turning largely upon the fundamental points of the legal right of the government to undertake scientific work, and the desirability of its so doing.

The president of the section next presented a paper entitled 'Competition and coöperation synonymous terms,' in which he maintained that the final result of competition is to better the condition of the laborer, and to improve the quality of the product. Like the forces of nature, it produces occasional great disasters, but produces its beneficent results silently and unnoticed. The competition of laborer with laborer is occasional; that of capital with capital constant, and to the advantage of labor. Since the beginning of this century, working-people have been receiving an increasing share of an increasing product.

The day's session was concluded by a paper by Mr. Charles W. Smiley upon some defects of our savings-bank system, and the need of postal savings banks in the United States, in which the writer presented the well-known arguments in favor of postal savings banks, some of which were rather severely handled in the ensuing discussion.

The short morning session on Monday was occupied with a paper by Dr. G. W. Hubbard of Nashville, Tenn., on vital statistics of the colored people of the southern states. The death-rate among the negroes in the cities and large towns is much greater than among the whites; while, so far as the confessedly imperfect statistics show, the birth-rate is not greatly different. The writer instanced the three cities, Chattanooga, Memphis, and Nashville. In the latter, very carefully kept statistics for the past ten years give an annual death-rate per 1,000 of from 17 to 26 for the whites, and of from 27 to 50 for the blacks. The other two cities showed nearly the same proportion. The birth-rate in Nashville, according to official statistics, was in the proportion of 1 white to 2 colored in 1881 and 1882, as 1 to 1 in 1883, and as 1 to a trifle over 1 in 1884. These figures, however, the author put but little confidence in. The causes of the greater mortality among the negroes the author classed under the three heads of ignorance, poverty and its attendant evils, and race characteristics. He considers that the condition of the negroes is gradually improving in the first two particulars. In regard to the prospects of an amalgamation between whites and blacks, attention was called to the fact, that, in most of the southern states, intermarriage of the races is a criminal offence; and that the proportion of illegitimate births of mixed parentage is small and decreasing.

The afternoon session was opened by a paper from Hon. C. S. Hill, statistician of the U. S. department of state, upon the science of statistical analysis, giving some account of the collection and publication of statistics by means of the consular service of the United States, and emphasizing the need of the application of a scientific method to the interpretation of statistics. This was followed by a paper upon social economy, by Dr. John Müller, which closed the day's session.

In his paper upon the silver question, Mr. E. B. Elliott of Washington, D.C., after recounting briefly the history of silver money in the United States, and alluding to the danger which at present menaces the finances of the country, proceeded to enumerate briefly the remedies, which were: 1°, to coin no more legal-tender dollars, but only subsidiary coins; 2°, to increase the weight of these subsidiary coins from 12.5 to 15 grams per half dollar, and to stamp each coin with its weight and fineness; 3°, to base all statements, weight of bars, bullion, etc., on the metric system. An interesting discussion followed, in which Professor William Harkness pointed out most clearly the great gravity of the problem, and commended the recent action of the New-York banks in endeavoring to tide over the danger of the payment of silver by the U. S. treasury in its settlements through the New-York clearing-house. He also alluded to the great temptation to counterfeiting which the present law offers, and stated that it was pretty well ascertained that a considerable amount of it had been done. He closed with the statement that we had allowed ourselves to be made a cat's-paw to

relieve European nations, particularly Germany, of their excess of silver.

The closing paper was also by Professor Elliott, upon electric lighting, giving the results of an examination of the system in use in the Philadelphia post-office. The system is the Weston; the incandescent lights employing an electro-motive force of 73.75 volts, and the arc lights a current of 80.05 ampères. One effective horse-power of the engine was required for 13.25 incandescent lights, and for 1.43 arc lights. One horse-power on the incandescent circuit gave a light equal to 237 standard candles, and on the arc-light circuit of 1,077.3 candles. In remarking upon these results, a member called attention to the low electro-motive force employed, and pointed out that this largely increased the safety of the system as compared with others.

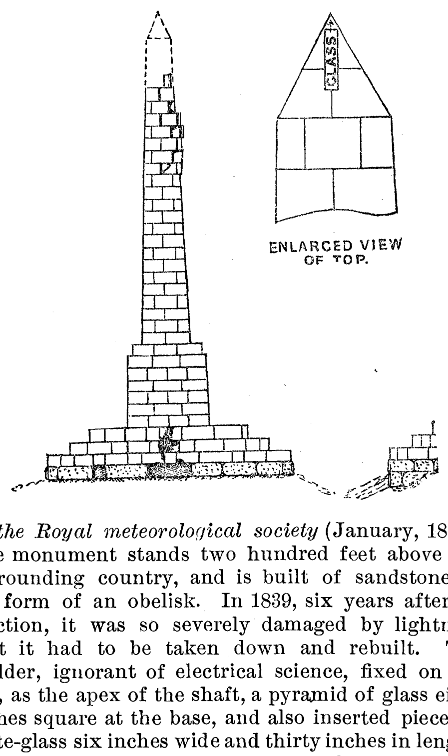
NOTES AND NEWS.

THE officers elected for the next meeting of the American association for the advancement of science, which will be held in Buffalo, commencing Aug. 18, 1886, are: president, Prof. Edward S. Morse of Salem, Mass.; section **A**, mathematics and astronomy, vice-president, Prof. J. Willard Gibbs of Yale College, New Haven, Conn.; secretary, Mr. S. C. Chandler, jun., of the Harvard observatory, Cambridge, Mass.; **B**, physics, vice-president, Prof. C. F. Brackett of the College of New Jersey, Princeton, N.J.; secretary, Prof. H. S. Carhart of the North-western university, Evanston, Ill.; **C**, chemistry, vice-president, Dr. H. W. Wiley of the department of agriculture, Washington, D.C.; secretary, Professor William McMurtrie of the Illinois industrial university, Champaign, Ill.; **D**, mechanical science and engineering, vice-president, Mr. O. Chanute of Kansas City, Mo.; secretary, Mr. William Kent of Jersey City, N.J.; **E**, geology and geography, vice-president, Prof. T. C. Chamberlin of the U. S. geological survey, Beloit, Wis.; secretary, Prof. E. W. Claypole of Buchtel college, Akron, O.; **F**, biology, vice-president, Dr. Henry P. Bowditch of the Harvard medical school, Boston, Mass.; secretary, Mr. J. C. Arthur of the N.Y. experiment station, Geneva, N.Y.; **H**, anthropology, vice-president, Mr. Horatio Hale of Clinton, Ont.; secretary, Mr. A. W. Butler of Brookville, Ind.; **I**, economic science and statistics, vice-president, Mr. Joseph Cummings of Evanston, Ill.; secretary, Mr. H. E. Alvord of Houghton Farm, Mountainville, N.Y. No nominations were made for section **G**, histology and microscopy, as it has been decided to merge it in the biological section. The permanent secretary is Mr. F. W. Putnam of the Peabody museum, Cambridge, Mass.; the general secretary, Prof. S. G. Williams of Cornell university, Ithaca, N.Y.; the assistant secretary, Prof. W. H. Pettee of the University of Michigan, Ann Arbor; and the treasurer, Mr. William Lilly of Mauch Chunk, Penn.

— The Germans hold the fifty-eighth meeting of their association of naturalists and physicists this year at Strassburg, Sept. 17–23.

— The Anthropological congress, which is shortly to be held at Rome, will have a curious feature in a collection of 700 skulls of criminals, numbered and classified. To these, says *Nature*, will be added the photographs of 3,000, and the brains of more than 150 convicts; thousands of autographs, poems, sketches, and special instruments, the work of criminals; an album containing a record of 700 observations, physical and moral, on 500 criminals, and on 300 ordinary men. There will also be graphic maps of crime in Europe, with reference to meteorology, food, institutions, suicide, etc.; tables of the stature of criminals in relation to the length of the arms, and of crime in towns compared to that in the country. Mr. Bertillon will exhibit the graphic curves of 23,000 *recidivistes* examined in twelve parts of the body, and the practical results obtained. Photographs of Russian political and other criminals, especially of those from Moscow, and wax masks of a large number of celebrated criminals, will also be exhibited. All the notabilities in the science of criminal anthropology will take part in the congress.

— On the 28th of April, 1884, during a very severe thunder-storm, the monument of the first duke of Sutherland at Lilleshall, Shropshire, Eng., was struck and badly injured by lightning. Mr. C. C. Walker, who was near by during the storm, made a careful study of the monument and its surroundings, the results of which are published in the *Quarterly journal*



of the Royal meteorological society (January, 1885). The monument stands two hundred feet above the surrounding country, and is built of sandstone in the form of an obelisk. In 1839, six years after its erection, it was so severely damaged by lightning that it had to be taken down and rebuilt. The builder, ignorant of electrical science, fixed on the top, as the apex of the shaft, a pyramid of glass eight inches square at the base, and also inserted pieces of plate-glass six inches wide and thirty inches in length, in grooves cut in the sides of the shaft, thinking, no

doubt, that this, being a non-conductor, would prevent a repetition of the accident of 1839. The accident which occurred in 1884 completely destroyed the upper ten feet of the obelisk; and the next nine courses of stone for about fifteen feet were all displaced, and pushed out from the central axis, and were in danger of falling. The platform was broken by the falling stones, large stones on the circumference of the platform displaced, and some of the faces of the sides forced out altogether. The sod round the base of the monument was ploughed up in fifteen grooves three to six inches wide and ten to seventy feet in length, while the grass was scorched brown.

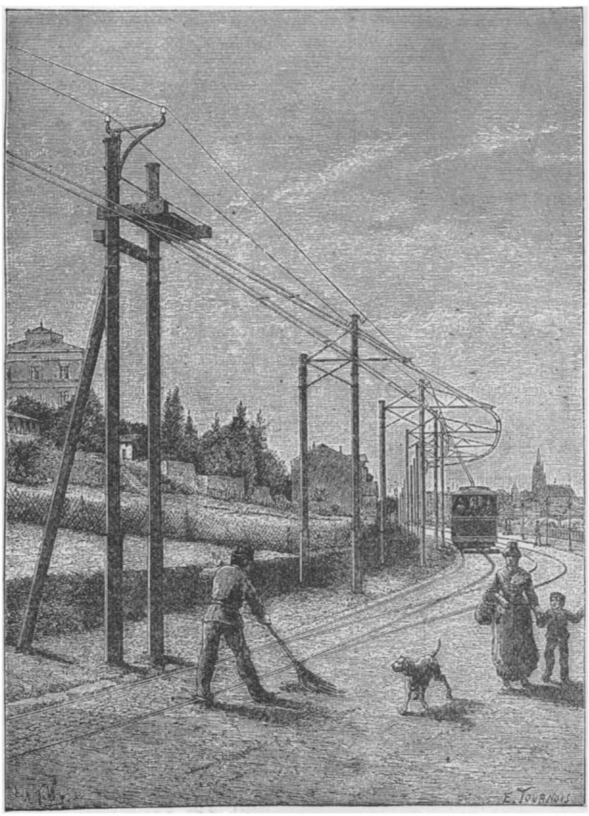
—Mr. S. C. Chandler, jun., has published in the *Astronomische nachrichten* a most interesting series of observations, — made with his newly devised instrument, the almucantar, — to determine the latitude of Harvard-college observatory. His results confirm the fact that the hitherto accepted value of the latitude requires a sensible correction. The new instrument gives results remarkably accordant among themselves, the latitude deduced from a set of seventy-three observations being $42° 22' 47.57'' \pm 0.028''$. Rediscussing, in the light of more recent determinations of the star positions, the old observations made by the Bonds and Major Graham in 1844–45, and by Gould at the Cloverden observatory in 1855, and combining these with observations of his own in 1883–85, Mr. Chandler proposes for future adoption — as the rounded tenth probably nearest the true value of the latitude of the dome of Harvard-college observatory, $42° 22' 47.6''$, in place of the value $48.3''$ given in the *American ephemeris*, and $48.1''$ given in the *Berlin jahrbuch* and the *Connaissance des temps*.

—In *La lumière électrique* for April 18, Mr. B. Marynovitch has a long article upon the telephone used as a signal instrument. The early part of the article is devoted largely to telephone calls, and to the telephone used as a railway signal. At the conclusion of the article, some attention is paid to the use of the telephone for military purposes; and we here reproduce one of the illustrations showing an officer seated in a casemate observing the effect of shot upon a target near by. He is supplied with a telephone, by means of which he transmits the results to the battery.

—We have received a papyrographed circular announcing the 'American economic association,' whose objects are stated to be the encouragement of economic research, the publication of economic monographs, the encouragement of perfect freedom in all economic discussion, and the establishment of a bureau of information. To this statement of the objects of the association is appended a proposed 'platform,' of which the first plank expresses ardent opposition to the doctrine of *laissez-faire;* the second

asserts the belief that political economy is still in the first stages of its scientific development, for the accomplishment of which it must rely chiefly on the study of statistics and history; the third holds that the host of social problems which have arisen through the conflict of labor and capital cannot be solved without 'the united efforts of church, state, and science;' and the fourth disclaims all partisânship in questions of governmental policy, and especially in that of free trade and protection. We understand that the meeting for organization was planned to be held this week at Saratoga, during the session of the American historical association just closed, and was to be of a private character, the participants being those who have been invited by the initiators of the movement. The association is designed to be of an academic rather than a popular character; and several college professors and others engaged in economic work have signified their intention to assist in its foundation.

— In the early part of 1884, Siemens brothers constructed an electric railway between Frankfort and Offenbach. The two rods conducting the current were suspended by insulators from poles; and from the top of the car, wires ran to these rods. The illustration which we reproduce from *La lumière électrique* for Jan. 24 shows the arrangement at a crossing. The length of the line was 6,555 metres, and there were employed upon it four cars: the tension was 600 volts, and the efficiency from 50 to 80 per cent, according to the position of the cars.



— The sixth international congress of Americanists, which was to have met during the present month at Turin, is postponed to September, 1886, on account of the ravages of cholera in Spain, which would deprive the congress of the presence of Spanish Americanists.

— The first part of anencyclopedic dictionary in Bengali, edited by two native scholars, has just been published in India. It contains descriptive derivations of Sanscrit and Bengali words, with Sutras quoted from Panini the grammarian; Arabic, Persian, and Hindi words introduced into the Bengali language; notes on the ancient and modern religious beliefs of India, the Vedas, Purans, Tantras, and other sacred books; besides short articles embracing the whole range of modern science.

— The Ohio state university has instituted a 'short course' in agriculture to obviate the objection sometimes made, that the full course of four years required more time than the young farmer could afford. The new course covers two years. For admission to the lowest grade of studies in this course, examination will be required in arithmetic, English grammar, and geography; but those wishing to enter the classes in algebra, geometry, or physics, must also pass an examination in algebra. The course of study includes agricultural chemistry, botany, agriculture, horticulture, veterinary science, mathematics, physiology, physics, physical geography, and 'mechanical laboratory.'

A short course in agriculture has also been instituted by the university of Wisconsin, in the hope of attracting those who can devote only a small amount of time or money to these studies. The course is a strictly technical one, consisting of courses of illustrated lectures upon agriculture, agricultural chemistry, agricultural botany, and veterinary science. It extends over the twelve weeks of the winter term, and is designed to be very elementary and 'popular.'

— According to the latest returns of the English consul at Teheran, the population of Persia, which covers an area of 1,647,000 square kilometres, amounts to 7,653,000. Of 99 cities with a total population of 1,963,800 inhabitants, Teheran has 120,000; Tabris, 164,000; Ispahan, 70,000; Bushir, 60,000; Meshed, 60,000; Kerman, 71,000; Resht, 40,000; Jezd, 40,000; and Shiraz, Kirmashah, Hamadan, and Kashan, each 30,000.